Popular Science Monthly

Most Wonderfully Illustrated Magazine in the World

AUGUST, 1924; Vol. 105, No. 2
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

Coming Next Month

Can Science feed you and me? Can chemistry supplant Nature's intricate processes of growing life, making us independent of crop failure and banishing forever the fear of hunger and famine? In POPULAR SCIENCE MONTHLY next month Ellwood Hendrick, Sc.D., nationally famous chemist and author, will tell you what our chemical laboratories are doing to solve the world food problem.

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Have you a cold? Do you know that a sure, safe, and easy cure for it has been discovered by the Chemical Warfare Service of the Army in the use of chlorine, the poison gas employed as a weapon of war? No doubt you have read of this discovery and have wondered just how effective it is. The truth about the chlorine treatment and its important results will be told next month.

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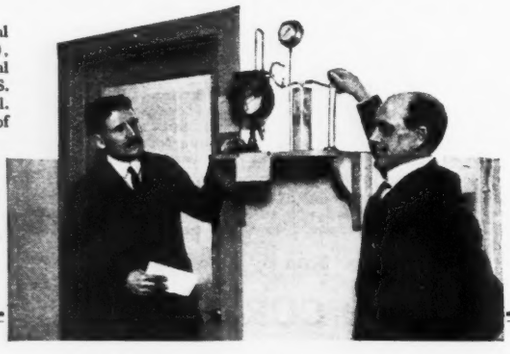
And more than 200 other fascinating articles and pictures giving you all the news of science and invention, together with practical ideas for radio, the automobile, the home, the home workshop, and the use of tools and machinery.

Brigadier - General Ames A. Fries (left), chief of the Chemical Warfare Service, U. S. Army, and Lieut.-Col. H. L. Gilchrist, chief of the Medical Division, demonstrating the apparatus used in the new chlorine gas cure for colds



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Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A.

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H. J. Fisher, *President* R. C. Wilson, *Vice-President*
O. B. Capen, *Secretary and Treasurer*

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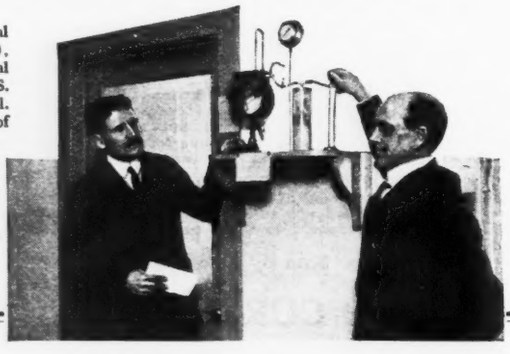

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And other timely articles and pictures

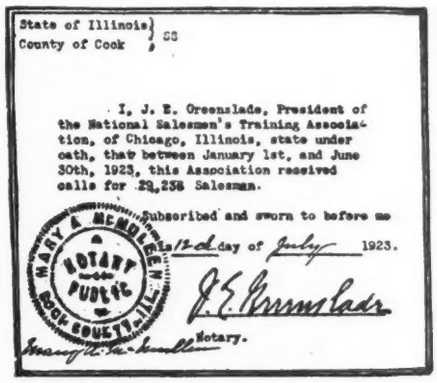
If You Want Bigger Pay Make This FREE TEST

There's a sure way to increase your earning power. And here is such an opportunity. Look into it—you may recognize it as your one chance to earn the biggest money of your life.

ARE you ready for a shock?

Then, let me tell you that if you have average intelligence and can read and write, there is a quick and easy way for you to double or triple your present salary—to earn enough money to satisfy any average ambition. And after reading this offer, if you do not quickly make more money, you have no one to blame but yourself.

Don't take my word for it. By a simple free test—one you can make in the privacy of your home—you will know that every word I say is true—or otherwise. The test does not obligate you or cost you one penny. But make it! Then judge for yourself. It has proved to be THE opportunity for thousands. They have found the way to bigger pay—are now earning from five to twenty times as much as formerly. And the beauty of it is they enjoy every minute in the day's work. They are their own bosses.


State of Illinois } SS
County of Cook }

I, J. E. Greenslade, President of the National Salesmen's Training Association, of Chicago, Illinois, state under oath, that between January 1st, and June 30th, 1923, this Association received calls for 23,238 Salesmen.

Subscribed and sworn to before me this 12th day of July 1923.

J. E. Greenslade

Notary.

NOTARY PUBLIC

A Field of Unlimited Opportunities

The thousands who have made this test before you, and who are now making the money you would like to make, are now salesmen. Ninety-five per cent. once thought they were not "cut out for selling," that salesmen were "born" and not made. They found it was a fallacy that had kept them in the rut. They discovered that any one with proper training can sell, and they are making from $5,000 to $10,000 a year because they had the vision to recognize opportunity.

Are trained salesmen in demand? Look at the affidavit on this page.

Thousands Have Proved It

For instance, Ellis Sumner Cook, 58 Superior St., Oak Park, Ill., left a $25 a week job and last year made $9,000! H. D. Miller, a Chicago boy, was making $100 a month as a stenographer in July, 1922. In September, 3 months later, he was making $100 a week as a salesman. W. P. Clenny, of Kansas City, Mo., stepped from a $150 a month clerkship into a selling job at $500 a month. He is making $850 a month now. M. V. Stephens, of Albany, Ky., was making $25 a week. He took up this training and now makes five times that much. J. H. Cash, of Atlanta, Ga., exchanged his $75 a month job for one which pays him $500 a month. O. H. Malfroot, of Boston, Mass., stepped into a $10,000 position as a SALES MANAGER—so thorough is this training. All these successes are due to this easy, fascinating and rapid way to master certain invincible secrets of selling.

These men were formerly clerks, bookkeepers, factory workers, farm hands, mechanics, machinists, chauffeurs, firemen, motormen, conductors, etc. Their success proves that previous experience or training has nothing to do with success in the selling field. It proves that any man who wants to, and who is willing to put in a few hours of spare time each week, can quickly get a selling position and make big money. And they started with this free test.

Why don't you make this free test and prove, to your own satisfaction, that a bigger salary is easy to get? The test is contained in a free book, "Modern Salesmanship," which we will gladly send you without obligation. After reading the book through you will ask yourself the questions it brings up. The answers will show you whether you can get away from the humdrum, small-pay job for the lucrative and fascinating work of selling.

Make This Free Test at Once

Don't turn this page until you have clipped the coupon, filled it out, and sent it on its way. It may mean the turning-point in your life. Write now while the impulse to succeed is upon you.

WORLD'S OLDEST AND LARGEST SALESMANSHIP TRAINING INSTITUTION — NATIONAL SALESMEN'S TRAINING ASSOCIATION

NATIONAL SALESMEN'S TRAINING ASSOCIATION

53 W. Jackson Blvd., Dept. 15-K, Chicago, Illinois

National Salesmen's Training Association
53 W. Jackson Blvd., Dept. 15-K, Chicago, Illinois

Gentlemen: I will accept a copy of "Modern Salesmanship" with the understanding that it is sent to me entirely free.

Name.....

Address.....

City..... State.....

Age..... Occupation.....

Money Making Opportunities for "Popular Science" Readers

AUTOMOBILES AND ACCESSORIES

PATENTS—Write for our Guide Books and "Record of Invention Blank" before disclosing inventions. Send model or sketch of your invention for our free Examination and Instructions. Terms reasonable. See advertisement on page 105. Victor J. Evans & Co., 189 Ninth, Washington, D. C.

AUTOMOBILE Parts—Used parts for most any car at half factory list prices. Allen, Briscoe, Buick, Cadillac, Chalmers, Chevrolet, Dodge, Dort, Grant, Hudson, Hupmobile, Oakland, Overland, Oldsmobile, Reo,Studebaker and many others. Send list of parts wanted. Maxwell Bros., 4105 Olive Street, St. Louis, Missouri.

$1.25 BUYS a positive Headlight Tell-tale. Handy Specialty Co., Somerville, Mass.

SPORT Speedster and racing bodies for Fords; build to order. Build your own Bucket Seat speedster. Send $1.00 for blue prints, instructions, and life size paper patterns, complete; Keller Auto Body Co., Inc., Dept. 24, 317 W. Winkler Ave., Louisville, Ky.

NO Car is Modern unless having the Auto-Lavatory that keeps motorists clean. Instant Service Soap and Water. Automobile Show Sensation. Special Demonstrator Price. Distributors Wanted. Emmons Manufacturing Co., Canton, Ohio.

MONEY!—Silvering autolights, radiators, mirrors. Refinishing tableware, stoves, brass beds, etc. Outfits, Methods free. Write—Sprinkle-Plater, Dept. 96, Marion, Indiana.

WHAT do you need? We have it. Gray's Auto Parts Company, 3212 Brighton Road, Pittsburgh, Pennsylvania.

M. P. LAUGHLIN—Patents-Engineer-Attorney-Specializing Power-Automotive Inventions. 47 West 42nd St., New York.

CLEAN your car for 5c. Dri-Klean-It removes mud, dirt, dust. No soap or water. Agents wanted. Write Amer. Accessories Co., Dryclean 279, Cincinnati, Ohio.

BUY a Gas Gun for $2.50 and avoid stopping on the road because out of gas. Handy Specialty Co., Somerville, Mass.

AVOID "turning turtle," leaving the road, locking over center. You can steer safely and easily out of ruts, through mud, sand, snow and on center-crowned roads, with a Sprague Worm Steering Gear on your Ford. Same type as used on all larger cars. Prevents bumps in road from turning front wheels aside; gives you control of steering. Also absorbs shock, vibration and strain on arms and shoulders. Makes a far better and safer car. Easily, quickly installed; no holes to bore; outlasts car. Guaranteed to satisfy you. Write for particulars. Sprague Tire Co., Dept. 2, Omaha, Neb.

FORD ACCESSORIES

SPEEDSTER fans—see "Red-i-Kut" ad. page 110.

MOTORCYCLES, BICYCLES, SUPPLIES

OVERSTOCKED—200 Used Motorcycles. Must be sold at once. We have Harley-Davidsons, Indians, Hendersons, Excelsiors, Clevelands. Prices $25.00 Up. Write for our Bargain List. Myerow Brothers, Dept. C, 15 Berkeley St., Boston, Mass.

DON'T buy a bicycle motor attachment until you get our catalogue and prices. Shaw Mfg. Co., Dept. 4, Galesburg, Kansas.

USED parts for all motorcycles cheap. Schuck Cycle Co., 1922 Westlake, Seattle, Wash.

MOTORCYCLE sidecars—Bargain prices on experimental and discountinued models. Write Fixible Co., 337 Water Street, Loudonville, Ohio.

MODELS AND MODEL SUPPLIES

HULIT & Co., 625 Jackson, Chicago, Ills. Experimental Machinists. Model Makers. Dies. Patterns. Complete general Machine shop. Ex-Lamson.

WE make working models for inventors and experimental work, and carry a complete stock of brass gears and model supplies. Send for catalogue. The Pierce Model Works, Tinley Park, Illinois.

EXPERT Model Making, modern equipment, reasonable prices. American Patents Corporation, 635 F St., Washington, D. C.

MOTORS, ENGINES AND MACHINERY

MOTORS—Manufacturer's Surplus Sale. ¼HP, $8.50; ½HP, $32.50; 1 HP, $54.50. 8 Volt Charging Generators, $8.50. Complete Lighting Plants—Generators—Light Machinery. Write for Catalog. Motor Specialties Co., Crafton, Penna.

BIJUR Generators, brand new, 6 volts, maximum output 22 amperes at 2000 r. p. m. Government paid $45.00 each, our price $10.00. General Sales Company, 1921 S. Michigan Avenue, Chicago, Illinois.

CONCRETE Building Block Machines and Molds Catalogue free. Concrete Manufacturing Co., 307 So. Third St., St. Louis, Mo.

MANUFACTURING

PATENTED Articles, Models, Brass Work, Machine Construction; Dies Made. Baum's Metal Specialties, Kansas City, Mo.

DIES, Tools and General Manufacturing. Models and manufacturing of new inventions our specialty. Logan Machine Co., 126 S. Clinton St., Chicago, Ill.

DEVELOPING ideas and manufacturing our specialty. Absolute satisfaction. 33 years' experience; write us. The K. & B. Die & Specialty Co., 2018 Elm St., Cincinnati, Ohio. Dept. C.

WANTED—TO BUY

CASH for old gold, silver, platinum, teeth, magneto points. Prompt payment. Mail to N. Ubler Co., 117 N. Dearborn, Chicago.

Another $25.00 IN PRIZES

To win one of these cash prizes is easy, and every reader is invited to enter this fascineting competition. Just write a letter of not over seventy words answering this question:—

What Advertisement of "Money Making Opportunities" in this issue interests you most and why?

Here are the prizes we will pay for the ten best letters answering the above question:—

First Prize	**$10.00**
Second Prize	**5.00**
Third Prize	**3.00**
And 7 Prizes of $1.00 each	**7.00**

First read every one of the "Money Makint Opportunity" advertisements on pages four to seventeen. Check the ones that interest you. Then read over the ones you have checked and decide on the one that interests you most.

Then write a short letter, not more than seventy words, telling us why the advertisement you pick interests you most. Remembet that ten prizes will be awarded. You have a good chance of winning one of them. Be sure to mail us your answer before August 1st. The prizes will be awarded, in the order of their merit, for the letters that are most interesting and best expressed.

The names of all the prize winners and the letters that win the first two prizes will be printed in this column in the October issue. Address your prize letter to

Contest Editor
POPULAR SCIENCE MONTHLY
225 West 39th Street, New York City

Last Month's Prize Winners

The First Prize of $10.00 goes to William S. Little, Rochester, New York, for his letter on the advertisement of "Money Making Opportunities." Here is Mr. Little's letter:—

Dear Sir:
Your own ad interests me most:—"Money Making Opportunities."
It increases the advertising value of every ad listed under it by making it worth while for thousands, who otherwise might not read one ad, to read all. And the more who read ads, the more responses to them—the more responses, the more advertising business for Popular Science!
Last but not least the chance to make "ten bucks," interests me!
Yours truly,
WILLIAM S. LITTLE.

H. L. Rozzele, Chattanooga, Tennessee, wins the Second Prize for the following letter regarding the advertisement of the R. J. Carnes Company. Here is Mr. Rozzele's letter:—

Dear Sir:
Having read every one of the advertisements in the "Money Making Opportunities," I find I am interested most in the small advertisement of R. J. Carnes, because I enjoy typing authors' manuscripts; for one not only earns "spending money," but also gets the pleasure of reading some fine stories before they appear in the magazines for the public.
Very truly,
H. L. ROZZELE.

The Third Prize goes to Fred Even, 2525 Central Avenue, Dubuque, Iowa.

The winners of the other seven prizes are:—

Mrs. J. W. Grubbs, St. Louis, Mo.; Vernon L. Baldwin, Durham, New York; Bertha Mundy, Marietta, Minn.; William F. Sandmann, Indianapolis, Ind.; Adele M. Nolin, Astoria, L. I., N. Y.; R. Melrose, St. John, N. B.; Frank G. Davis, Harrisonburg, Va.

Rate 25 Cents a Word. Advertisements intended for the October issue should be received by Aug. 5th.

RADIO AND SUPPLIES

RADIO Sets: Super-Heterodynes, Neutrodynes and other standard types all makes; guaranteed; 50c off list. Why pay more? Send for bulletin 245 Radio Exhange, 925 Broadway, New York.

RECHARGE your worn out "B" Battery for 1c. Formula and Instructions 50c postpaid. Monarch Sales Company, O-we-go, N. Y.

RADIO Tubes repaired and exchanged; write for free circular, "How to do Away with Storage Batteries on All Tubes." C. F. E. Radio Tube Works, Essex Court, Newark, N. J.

RADIO Generators: 500v 100 watt, $28.50. Battery Charging Generators, $8.50. High Speed Motors. Motor Generator Sets all sizes. Motor Specialties Co., Crafton, Penna.

2,650 MILES Distance with one tube. Any Novice understands our Simplified Instructions, including Panel Layout and Photo 25c. Vesco Radio Co., Box PS 117, Oakland, Calif.

RADIO tubes, D11, D12, UV199, UV200, UV201A, $1.25. Dutch radio tubes, D12, D200, D201A, $2.50. Crystal set, 50c. Add postage. Radio Sales Co., 1168 North Kingshighway, St. Louis, Mo.

WHY Not Reach Out with your crystal set? There's music on your aerial every night from stations far away! I have shown thousands of people how to hear long distance programs without tubes. Write me today. Leon Lambert, 670 South Volutsia, Wichita, Kansas.

FOR THE HOME

HOME weaving—looms only $9.90. Big money in weaving rugs, carpets, portieres, etc., at home from rags and waste material. Weavers are rushed with orders. Send for free loom book, it tells all about the weaving business and our wonderful $9.90 and other looms. Union Loom Works, 482 Factory St., Boonville, New York.

GRANDFATHER clock works $5.00. Build your own case, instructions free; make good profits selling your friends. Clock works with chimes for old or new cases. Write for full particulars. Clock Co., Nicetown, Penn.

GASOLINE lamps, lanterns and heaters. Catalog free. Little Wonder Mfg. Co., Terre Haute, Indiana.

KIDDY Kabinet—Ornamental, fascinating, useful, instructive. Actual size patterns. Instructions, 25c, 50c, coin. Guaranteed satisfaction. Bogrens Kiddy Kabinets, 2651-8th Ave., New York.

TRADE AND TECHNICAL SCHOOLS

EARN $10 to $20 per day. Learn sign painting, Auto painting, decorating, paperhanging. Be an expert in a few weeks—Low cost—Actual work—No books—Catalog Free. Chicago Painting School, 157 West Austin Avenue, Chicago.

CHICAGO Technical College offers short, intensely practical courses in Drafting and Engineering—civil, mechanical, electrical, structural—Architecture, Building Construction, Plan Reading, etc. Courses fitted to your needs. No time wasted. Instructors are experts. Graduates in demand at big salaries. Opportunities for part-time work while studying. Day and evening classes. 21st year. Enter any time. No special preliminary training required. Low tuition—easy terms. Write for 52-page illustrated Blue Book, describing opportunities open to our graduates. Chicago Technical College, 23 Chicago Tech. Building, Chicago.

BE a Bricklayer. Attend a school operated by Building Contractors. Three Months Day Course $75.00. Associated Building Employers, 128 A. B. E. Building, Grand Rapids, Mich.

AVIATION

THE American School of Aviation announces a new correspondence course in mechanics of aviation. A thorough training in practical aeronautics. American School of Aviation, Dept. 674-B, 3601 Michigan Ave., Chicago, Illinois.

BOYS get a three foot model aeroplane free. Nothing to sell. Write to Aero Shop, 3050 Hurlbut Ave., Detroit, Michigan.

WANTED

TYPISTS—Earn $25-$100 weekly in spare time copying authors' manuscripts. Write R. J. Carnes, P-1, Tallapoosa, Georgia, for particulars.

OLD gold, silver and platinum for cash. Penn Laboratories, 222 Market St., Newark, N. J.

WANTED: Light Machinery, Lathes, Drill Presses, Model High Speed Gasoline and Steam Motors. Best Cash Prices Paid. Motor Specialties Co., Crafton, Penna.

DETECTIVES needed everywhere. Experience unnecessary. Particulars free. Write, George Wagner, former Government Detective, 1968P Broadway, N. Y.

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More Money Making Opportunities on pages 6 to 17

Learn Electricity

Earn $70 to $200 a Week Doing Work You Enjoy

ELECTRICITY Needs Trained Men at the Highest Pay. In a Few Short Months I Can Train You to Fill One of These Big Jobs

Men like you are needed right now in the fascinating Big Pay Field of Electricity. Never before was there such a demand for men at such high salaries. Get into this big pay game now. Get a real job doing work you will like. I have made it easy for you to earn $70.00 to $200.00 a week. Yes Sir—$3,500.00 to $10,000.00 a year—and I'll help you get just the job you want and back it all up with a signed money back guarantee bond.

Learn at Home to Earn $12 to $30 a Day

Even the common ordinary electricians are making money—big money—money that outclasses all other trades. But I will make you more than an electrician. In a few short months you can be an Electrical Expert earning $12.00 to $30.00 a day. I will do this for you right in your own home and in your spare time. Follow my simplified, easy to understand method and you will quickly learn to fill any one of the many big jobs that are continually open to trained men.

Other Men Like You Are Doing It. You Can Do It Too

Last year 4280 of my students and graduates reported better jobs and pay increases. The names of some of them are in the panel directly above. These men all earn from $60.00 to $200.00 a week and they are the happiest and most prosperous bunch of men you ever saw. You might call it luck if one or a dozen of them jumped from little "two by four" jobs into the big pay class but when thousands have done it you know positively that my training alone was responsible and that it will do the same for you.

Lack of Experience or Education Is No Handicap

If you have the average man's intelligence and can read and write, I can do what I said—quickly fit you to earn $70 to $200 a week—$3,500 to $10,000 a year—as an Electrical Expert. My Course is so different from ordinary courses that it has revolutionized home study training. There is nothing else anywhere near like it.

It is the simplest, easiest to understand, and yet the most thorough and complete Course of electrical training in the Country today. With it, any ambitious man, regardless of age, lack of education or experience, can quickly become a big success in the wonderful, fast growing field of electricity.

Look What These Men Are Earning

J. R. Morgan of Delaware, Ohio, earns from $30.00 to $50.00 a day since completing my course. He used to earn $5.00 a day as a carpenter's helper. W. E. Pence, a $35.00 a week mechanic of Chehalis, Wash. made almost $10,000.00 last year doing electrical work in a town where he didn't think he could earn a dime. Harold Hastings of Somers, Mass., only 21 years old, cleans up $480.00 a month. He was still in high school when he started on my course. Joe Cullari, 523 N. Clinton Ave., Trenton, New Jersey, increased his income 300% in one year and frequently makes the entire cost of his course back in one day's time. G. L. Sigety, 901 Standard Life Bldg., Pittsburgh, Pa., only 19 years old, jumped from $10.00 a week to $60.00 a week with his studies only half finished. Herbert Dickerson on a farm near Warrenton, Virginia, made $7,500.00 last year applying the electrical training I gave him to farm work.

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Mail Coupon Now

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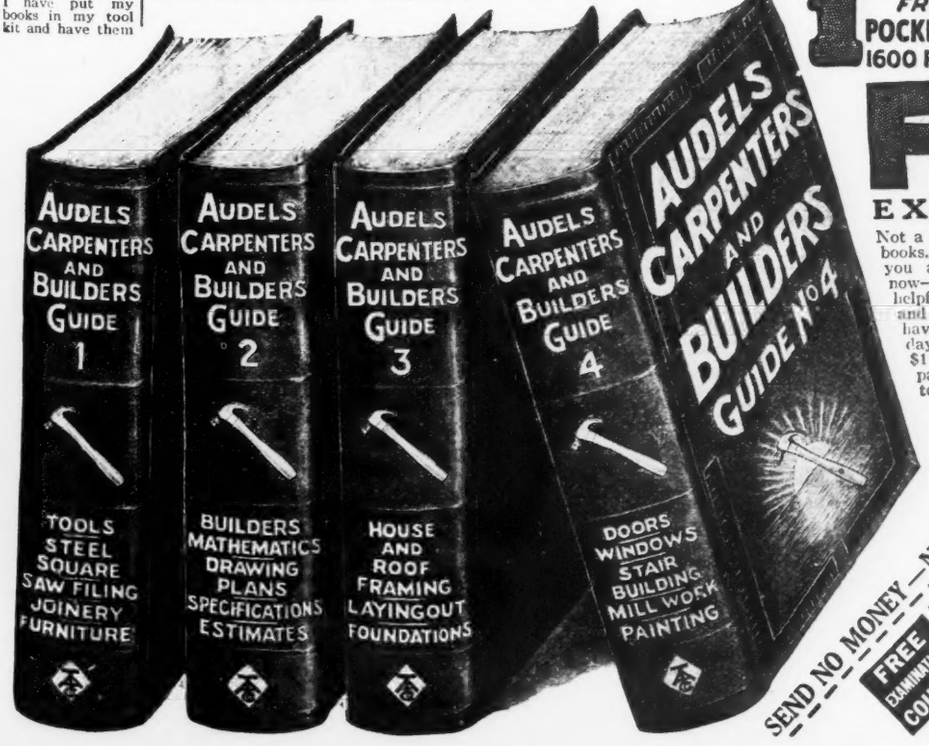
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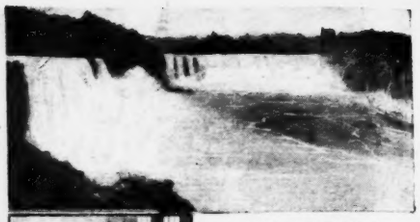

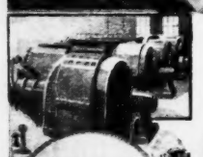

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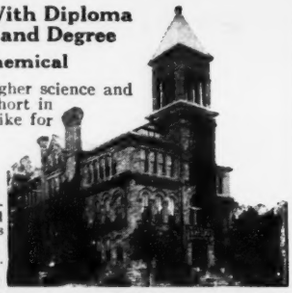

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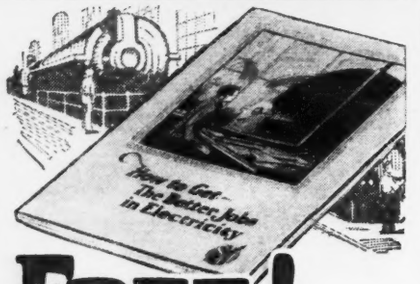

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$10.00 DAILY easily made selling Needle Cases; retails 25c. Send 10c for sample. Mail Order House, Wilmerding, Penna.

ARE you old at forty? See our advertisement on page 100 of this issue. The Electro Thermal Company, 4036 Main Street, Steubenville, Ohio.

EARN $10 daily silvering mirrors, plating and refinishing metal ware, headlights, chandeliers, bedsteads. Outfits furnished. F. Decie Laboratories, 1133 Broadway, New York.

More Money Making Opportunities on pages 4 to 17

"I'm Going to Make More Money!"

"I'm tired working for a small salary. I know I have just as good a head on me as Fred Moore and Bob Roberts, for we used to work side by side. But they've gone far ahead of me.

"Why? Because they saw the value of special training, and I didn't.

"But I know better now. If the International Correspondence Schools can raise the salaries of men like Fred Moore and Bob Roberts, they can raise mine, too!

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Persons residing in Canada should send this coupon to the International Correspondence Schools Canadian, Limited, Montreal, Canada

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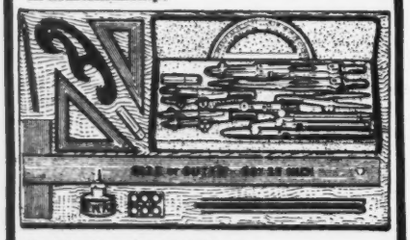

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Money Making Opportunities

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More Money Making Opportunities on pages 4 to 17

Elements of Industrial Chemistry

By Allen Rogers

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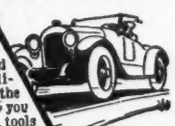

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More Money Making Opportunities on pages 4 to 17

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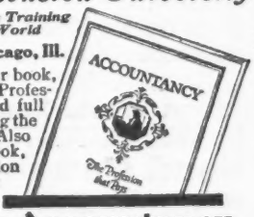

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More Money Making Opportunities on pages 4 to 17

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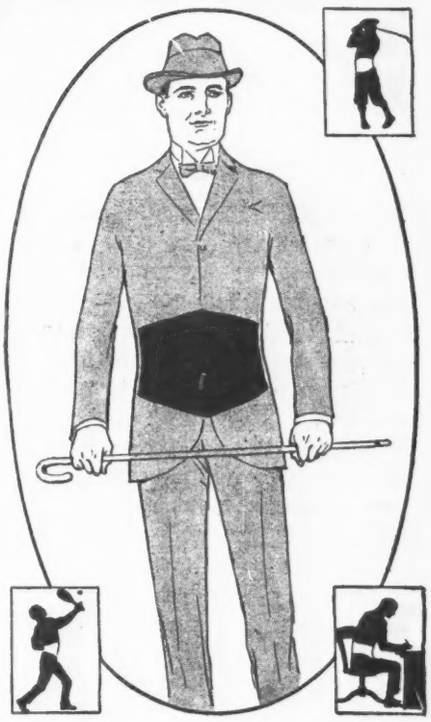

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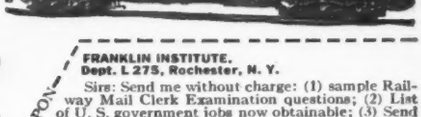

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More Money Making Opportunities on pages 4 to 15

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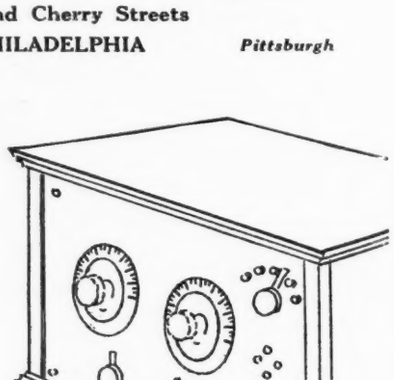

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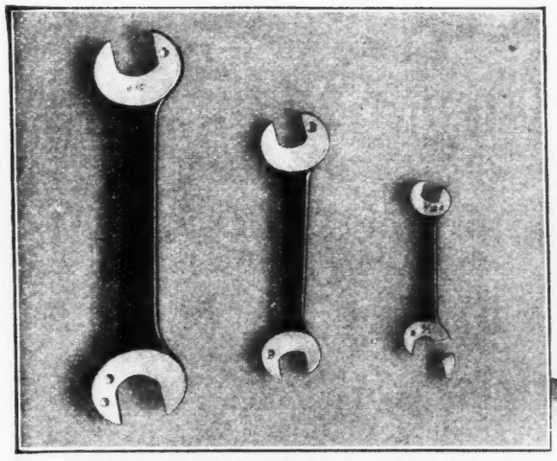
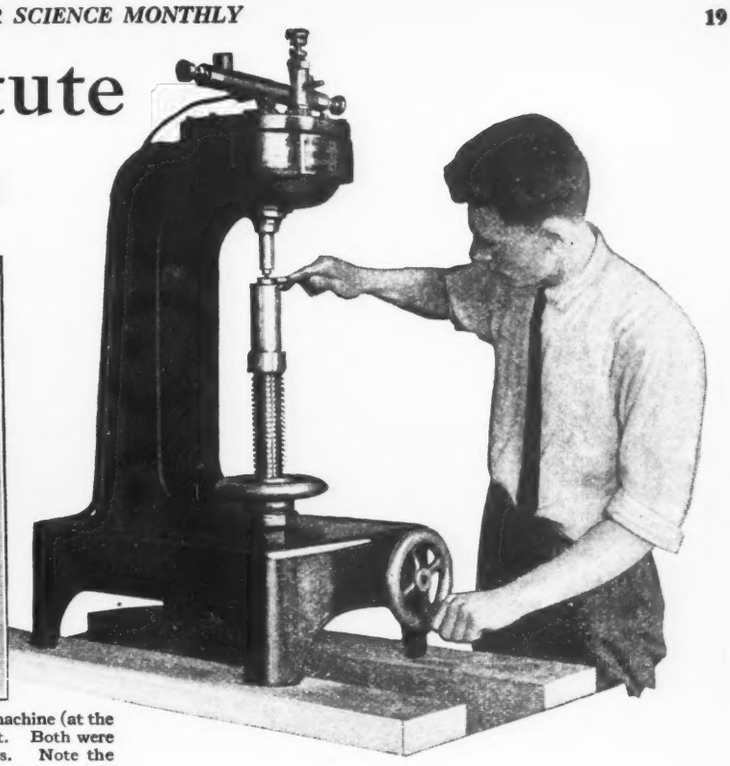
How the Institute Tests Tools





Three wrenches subjected to the hardness tests by the "Brinell" machine (at the right). The smallest tool was too brittle; the center one too soft. Both were rejected by the Institute. The largest wrench passed the tests. Note the circular indentations caused by pressure of a super-hardened steel ball

By Collins P. Bliss, M.A.

Director of the Popular Science Institute of Standards

AN OPEN-END wrench that sells for 10 cents looks the same as a wrench that sells for 30 cents. But looks are only "skin deep." It is what is under the finish that determines whether a wrench, or any other tool, will stand up under the wear and tear of everyday use.

Usually the only way a layman has been able to tell whether a tool will do the work for which it is designed has been by actual use. But now, by buying tools that have been approved by the Popular Science Institute of Standards, the layman is assured of satisfactory service. Before the Institute approves a tool it is subjected to severe laboratory tests and critical examination by the Institute's engineers.

In the case of an open-end wrench, for example, the first test is the hardness test. Such a tool may be made of steel so soft that its jaws soon would become deformed. On the other hand, the steel might be so brittle that strong pressure on the wrench would break the jaws. Somewhere between these two extremes of hardness and softness is a happy medium that is ideal for the manufacture of tools of the highest quality.

INCLUDED in the $300,000 worth of testing apparatus available in the laboratories where Popular Science Institute of Standards' tests are conducted, are two ingenious machines that are used to determine exactly the hardness of tool metals. One is called the "Brinell" Testing Machine; the other, the Shore scleroscope.

In the "Brinell" machine the wrench is placed so that a super-hardened steel ball rests on the spot to be tested. The ball is pressed into the metal. The depth to which it can be pressed provides the basis for calculations showing the hardness of the metal.

IF THE indentation near the jaws of the wrench is too great, it is obvious that the steel is too soft. If the indentation is not sufficiently great, the steel is too hard and brittle. In either case the tool is rejected by engineers of the institute.

In the Shore scleroscope the tool is struck by a small diamond-pointed hammer falling freely from a height of about 10 inches. By measuring the rebound of the hammer, engineers can determine the hardness of the steel. By dropping the hammer on various parts of a tool, we can ascertain whether the steel on the edge, or near the edge, is hard enough to stand up under use, and whether the shank is not too hard for the proper toughness.

These hardness tests are extremely important in testing not only wrenches, but almost all tools. In a wood chisel, for example, if the metal is too soft, the edge soon will wear and the chisel will not cut. On the other hand, the steel may be so brittle that a slight force will chip the edge. Even in a hammer it is possible that the metal may be too hard or too soft. A saw requires varying degrees of hardness, ranging from very hard at the teeth to comparative softness in the back of the blade.

Hardness is only one of the many qualities for which tools are tested before they are approved by the Institute. When you purchase tools approved by our engineers, you know that you have a product that is correctly designed and will withstand normal usage.

Send for list of Approved Products

POPULAR SCIENCE MONTHLY will be glad to furnish, upon request, a list of Radio and Tool manufacturers whose products have been tested and approved by the Popular Science Institute of Standards.

POPULAR SCIENCE *Monthly*

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POPULAR SCIENCE MONTHLY
SUMNER N. BLOSSOM, Editor
August, 1924

A Wonder House of Science

By Raymond J. Brown

When President Coolidge recently dedicated the beautiful new national home for science, opened at Washington, D. C., by the National Academy of Sciences and the National Research Council, he declared that "the magnificent building predicts a new day in scientific research." In the following article Mr. Brown tells of a visit to this great public shrine of knowledge and of the wonders he found available there to every American.

A FEW weeks ago I had the thrilling experience of visiting a modern house of wonders where science plays the host.

This house of wonders is a stately building of creamy marble, picturesquely situated near the banks of the Potomac at Washington, D. C. It was erected and opened recently by the National Academy of Sciences and the National Research Council to provide science with a place to keep open house for its friends, old and new; to entertain them, thrill them and amaze them by a display of the marvels of nature and the newest discoveries of scientific workers.

The place is neither museum, scientific laboratory, nor theater. And yet it is all of these—and more. The glass cases for exhibits and the familiar warning "Hands Off!" of the conventional museum are conspicuously absent. The exhibits are in plain sight, unguarded and unprotected.

More, you and I, when we call on science in its new home, are urged and invited to handle the exhibits, to play with them and experiment with them as much as we please. Though they are made up in great part of the most delicate, intricate and expensive instruments of the modern scientific laboratory, they are not reserved for the exclusive use of experts, as would be the case in a laboratory. You and I, whether we be scientists or merely casual sightseers at the national capital, are permitted to make free use of the apparatus.

On every exhibit are attached plain directions, which instruct us how to turn the switches, to press the buttons, to focus the eye pieces.

The purposes of the experiments are explained; we carry them on with our own hands, observing the details of the successive stages with our own eyes, and we appreciate the significance of the conclusion as we never could were we merely to read of it or to hear it discussed by a lecturer. No theater could provide a spectacle more amazing than this almost bewildering array of scientific wonders, made tangible and understandable to all who come to see.

One of the wonder rooms in the new home of science. Here you can make a chemical analysis of the sun, or at least detect the presence of iron in the sun. The visitor is seen looking through a spectroscope that splits up the sunlight into its spectrum in the basement below. Simply by pressing a switch, a spectrum of burning iron is projected on the solar spectrum, and the lines of the iron spectrum are seen to coincide with those of iron in the solar spectrum. On the disk in the center of the pedestal is projected an image of the sun on which you can see sun-spots. At the rear is a swinging brass ball suspended by wire from the top of the 60-foot dome, over a brass plate on the pedestal that demonstrates convincingly the principle of the rotation of the earth about the sun

THIS new national home of science is an institution unique in all the world. Its foundation marks a tremendous forward step in the efforts of present-day scientists to convey to the average man an appreciation of the importance and purpose of scientific research.

Scarcely had I stepped inside the massive bronze entrance doors, whose panels graphically depict the history of science from Aristotle to Pasteur, when I was confronted by visible proof of a fundamental marvel of creation, yet one which, even in this enlightened age, many persons undoubtedly accept largely on faith—the rotation of the earth about the sun.

IN THE center rotunda, suspended by a wire from the top of the 60-foot dome, a great brass ball was swinging slowly back and forth like the pendulum of a huge clock. On an ornamental pedestal just beneath it lay a brass plate, its surface ruled with fine lines radiating from its center. A pointer at the bottom of the oscillating brass ball made it simple to pick out the line with the direction of which the movement of the pendulum coincided.

I made note of the line along which the pendulum was swinging, but when I returned to the rotunda several hours later,

the pendulum was no longer following that line. It was moving along another line at an appreciable angle to the direction of the first line.

Apparently the swing of the pendulum had changed. But actually it had not. The direction of its oscillation was exactly the same as when I had observed it first. What had happened was that the earth had turned beneath it!

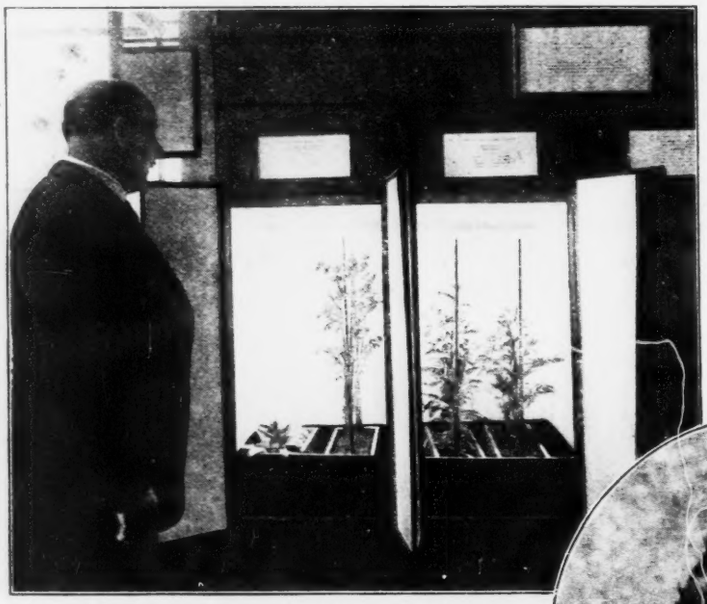
Front view of the Wonder House of Science, Washington, D. C., erected at a cost of $1,450,000, and dedicated to promote popular interest in science

EVEN before observing this pendulum for the first time (scientists call this apparatus the "Foucault pendulum"), I had been brought face to face with the fact that there are many amazing things about this earth of ours that most of us, plodding along about our workaday affairs, recall quite as infrequently as we do the fact that our seemingly stable earth is continually whirling through space.

There is the matter of earthquakes, for example. Ordinarily we hear only of the great disasters, such as the one that occurred last year in Japan, but earthquakes happen rather frequently—10,000 times a year, once at least every hour, according to the latest testimony of the scientists. There was graphic evidence of that fact on the broad recording tape of the new type seismograph that was the first thing I saw when I entered the building.

Here and there on the paper roll clicking through the machine were jagged breaks in the straight line that the recorder ordinarily describes. Each break was the record of an earthquake that had occurred somewhere in the last few days. They were small quakes, mere tremors, as I could see by comparing them with the record of the Japanese disaster, framed on the wall behind the instrument; yet they constituted a reminder that our "solid" earth consists merely of a shell surrounding a comparatively soft core; and that the outer covering is likely to break and slip at almost any time. There is a strange fascination in watching this instrument—waiting for an earthquake to occur so that you may see its vibrations.

Another phenomenon of nature, of which we are frequently and more or less unpleasantly reminded these days when almost everybody is interested in radio, is atmospheric electricity. We realize that the air is full of electricity every time static crackles in our earphones or loudspeaker and interrupts the radio program we have been enjoying. Just across the way from the seismograph, on the other side of the entrance hall, I found an instrument that registers and measures the amount of atmospheric electricity quite as readily as you would check up the voltage and amperage of your radio or automobile storage battery. Alongside of this was an instrument called the "magnetograph," which records the presence of electricity inside the earth, and clearly demonstrates that our earth is actually a great magnet.



In these glass cases you can see how science grows plants by electric light. The plants at the left, grown under artificial light, are taller and sturdier than those of the same species at the right, grown under natural sunlight

THERE is a definite connection between the facts that these instruments reveal. Both the earth and the air above the earth get their electricity from the sun, which, scientists say, is continuously bombarding us with a storm of electrons. Sometimes the surface of the sun bursts forth in great whirling eruptions. From these the bombardment of electrons pours out with a new intensity. The terrific electric hail is hurled against the upper strata of the earth's atmosphere. Then we see the aurora borealis. Terrestrial electricity increases correspondingly with the usual activity of the sun, often to such an extent that telegraph communication is interfered with. Once it even burned out an ocean cable.

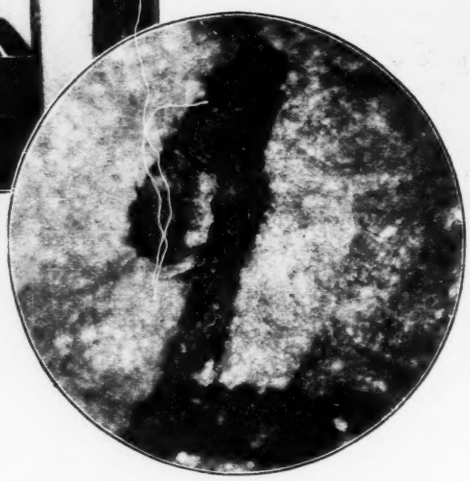
These instruments—the magnetograph and the electrograph—scarcely more remarkable in appearance than a small telescope, record the causes of these amazing phenomena. Marvelous instruments, you will probably say, as I did. But only a few steps away from them can be seen a still greater marvel—the cause, the actual source of the phenomena—the sun itself.

ON THE pedestal in the center of the rotunda above which the Foucault pendulum moves slowly back and forth is a white disk—eight inches or so in diameter. From the dome above a bright beam of light plays on this disk, illuminating its center with a dazzling circle of light, six inches across. This circle is an image of the sun, ingeniously projected on the table by mirrors and a lens in the dome.

Examining this closely I saw several faint specks. They appeared as if they might be streaks on the white disk, or the images of dust spots on the surface of the lens above. Actually, though, they were images of the eruptions in the sun from which the rain of electrons pours on the earth.

Sun-spots, astronomers call them, mysterious vortices of fiery gases that exert a profound influence on our weather and climate. Watch them for a few minutes, and they seem stationary and unchanging. Come back the next day, though, and the form of the spots has changed and their positions have shifted, for the sun is rotating even as our earth is.

That pedestal I found a veritable wonder box in itself. At one side of it was an eye piece. Looking through this I saw the beautiful spectrum of the sun with its seven colors, one melting into the other through intervening shades that made it difficult to say where one color ended and the next began.



An every-day wonder of the microscope—How the figure 2, written in ink on a plain piece of paper, appears when highly magnified

This spectrum is produced by permitting light from the solar image on the pedestal to pass through a narrow slit to an optical grating at the basement floor where the white light is resolved into its component colors and transmitted back as the spectrum.

Across the spectrum I saw innumerable dark lines. These lines are caused by the glow of the different chemical elements present in the sun. It was through these, by means of the spectroscope, an instrument similar to the one through which I was looking, that scientists were able to make chemical analysis of the sun, and later of the stars.

THE dark lines I saw in the spectrum seemed all the same. Yet they differ widely, as I was soon to see. Touching an electric button near by, I started an electric arc, causing its iron poles to vaporize. The light from the burning iron descended through the slit beside the light from the sun. The light lines of this iron spectrum coincided with certain of the dark lines in the solar spectrum, demonstrating the presence of iron in the sun. Could I have projected the spectra of other chemical elements on the solar spectrum, their lines would have coincided with other dark lines there,

Light from a pocket flash travels around a corner. Here is a spectacular demonstration of the amazing light-conducting qualities of clear fused quartz, a substance 65 per cent more translucent than glass, recently developed in commercial quantity. Samples of the quartz in various stages of manufacture form one of the interesting exhibits

indicating their presence in the sun also.

In all history, probably, no wonder of science has taken such swift and violent hold of the public fancy as radio. And so, of course, in the new home of science there is a radio exhibit. However, it is nothing like any radio exposition you ever saw. You look in vain for the receiving sets and parts—loudspeakers, storage batteries, and similar apparatus.

Here the fundamentals of radio make up the show. You are shown, in short, just what radio is all about—exactly the things you ought to know if you're really interested in radio, but the things you probably never think about when you tune in to listen to broadcasting.

You've heard of a man named Faraday, I imagine. You probably know that he was one of the great pioneers of electricity. But did you know that it was Faraday who first conceived the possibility of wireless—using the ether as a medium of electrical transmission?

Stepping from the rotunda into the radio room that adjoins it, I found apparatus all set up for me to perform one of Faraday's epochal experiments, an experiment that led to the principles on

Would you like to see how your voice sounds? Simply speak into the telephone transmitter of this remarkable instrument, press a button, and the sound waves of your voice are converted into light waves that flash across the glass screen shown in the center of the picture

which radio and virtually all practical use of electricity today depend—a demonstration of the generation of magnetic lines of force by an electric current.

I pressed a button. Immediately the flow of electric current transformed what had been merely a coil of wire into a magnet. I released the button, and the magnet became merely a coil of wire again. Moving this coil about near another magnet, produced an electric current, a fact that I verified at the next table. Simple experiments, both of these; yet to what startling things have they led! Here, too, I saw the development of the vacuum tube by successive stages, and the foundation of radio telephony. I observed the beautiful effects produced by making an electric discharge through gases, the passage of electrons due to heat, and the action of a commercial vacuum tube. I was permitted also to exhaust a vacuum tube.

Then, too, I *saw* how my own voice sounds. That may sound absurd, yet here was an instrument called the "oscillograph" that converts sound waves into light waves and makes them visible—an instrument through which scientists were able to analyze human speech and so perfect the telephone, the radio headset and loudspeaker.

I PRESSED a switch and spoke into a telephone. Immediately, across a glass screen, passed an irregular flash of light. It persisted while I spoke, and stopped when I was silent. The flash resembled the markings on a phonograph record, greatly enlarged, which is scarcely remarkable inasmuch as the markings on a phonograph record are sound waves converted into visible scratches instead of into flashes of light. On a similar principle—the conversion of waves in one medium of transmission into waves of another medium—are based the telephone, radio and television, the transmission of pictures and distant scenes.

Perhaps you know of the interferometer, the marvelous instrument devised by Professor Michelson of the University of Chicago, who is president of the National Academy of Sciences, by which the distance, the diameter, and similar amazing things about the heavenly bodies have been learned. Professor Michelson has placed not one but three interferometers on exhibition in the science building. I say "on exhibition" purposely. Like everything else there, they are yours to use and experiment with if you wish. The difficulty is, though, that one must be an astronomer or a physicist to employ these instruments for their true purpose.

There is a little apparatus only a few feet away from the interferometers, however, that any one can use. It is the invention of the late Prof. Ernest F. Nichols, of the Nela Park Laboratory, Cleveland, Ohio, and it illustrates one of the newest discoveries of science—the pressure of light.

When a beam of light falls on you, it exerts a pressure against you just as if some one were to push you. The pressure is so faint that you cannot detect it, but science has shown that the fierce light that beats on the earth from the sun exerts considerable effect on the gravitational influence between the two bodies. In certain stars the pressure of light is so intense that it causes them to expand and tends to disintegrate them. It also is the force that pushes out minute particles to form the tails of comets.

WHEN I lighted a small electric lamp at the rear of the table holding this apparatus, a narrow ray was thrown against a glass scale before me. Then I pressed the switch controlling a larger lamp. The ray from this, striking the first ray at an angle, bent it from its path, a fact that was plainly discernible in the movement of the ray across the scale.

In the June number of POPULAR SCIENCE MONTHLY I told of the extraordinary properties of radium, the wonder element. In this new home of science you can see the wonders of radium yourself. Just across the hallway from the apparatus that demonstrates the pressure of light is a machine known as the Wilson-Shimizu apparatus. When you peer into an eye piece, you see a wonderful display of pyrotechnics in miniature—lightning-like flashes, a myriad of sparks, tracks of dazzling flame. It is as if you were watching from a vast distance a nighttime bombardment of a city by a mile-long line of field guns.

These tiny but energetic flashes are the alpha and beta particles shooting off from a bit of radium against a fluorescent screen

(*Continued on page 111*)

Nature's Super-Power Plant

Surprising Facts about Lightning and Your Safety

By George M. Ogle

Associate Member, American Institute of Electrical Engineers

THERE has been much talk recently of super-power. Eminent engineers have estimated that 80,000,000 horsepower in electrical energy could be produced by utilizing fully the water resources of the country; energy equivalent to that contained in 800,000,000 tons of coal, or 200,000,000 more tons than the total annual product of the mines of the United States.

Now, though the day of super-power is still far away, though the harnessing of all available streams in the country probably will remain for years merely a dream of imaginative engineers, it is altogether likely that most persons in the United States many times in the last few months have observed manifestations of electrical energy compared with which the 80,000,000 horsepower visioned by the prominents of super-power seem weak and feeble.

For every time there is a severe thunderstorm Nature discharges more electricity in the form of lightning than the total amount that could be produced by the simultaneous use of every generator, battery, and static machine that has existed since the dawn of electrical knowledge.

IN EVERY single flash of lightning you see is concentrated many times more energy than could be produced in an instant by all the electrical generating plants in the world. The present available electrical power in the world is about 10,000,000 horsepower, while the energy released in 1/200,000 of a second by the average flash of lightning is 250,000,000 horsepower—more than three times as much as engineers say they could develop by harnessing every stream in the United States!

Lightning is Nature's greatest show, and for many persons their supreme source of terror. The awe-inspiring magnificence of a large display of lightning is inescapable, but the terror of lightning probably can be traced to its mystery and to the resounding roars of thunder that accompany it rather than to its actual danger. Recent scientific research, however, has succeeded in stripping much of the mystery from the phenomenon and has unearthed reassuring facts that should allay much of the fear occasioned by violent electrical displays in the heavens.

Considering the enormous energy of a single bolt of lightning, it is surprising that there is comparatively little reason for man to be afraid of it, yet this statement is well substantiated by statistics.

It is true that lightning is the sixth most frequent cause of fire in the United States. Latest reports of the United States Weather Bureau show that it results in an average annual loss of more than $12,000,000, of which more than $1,000,000 is in the state of Illinois, with Texas second and New York third in the list of states that suffer most.

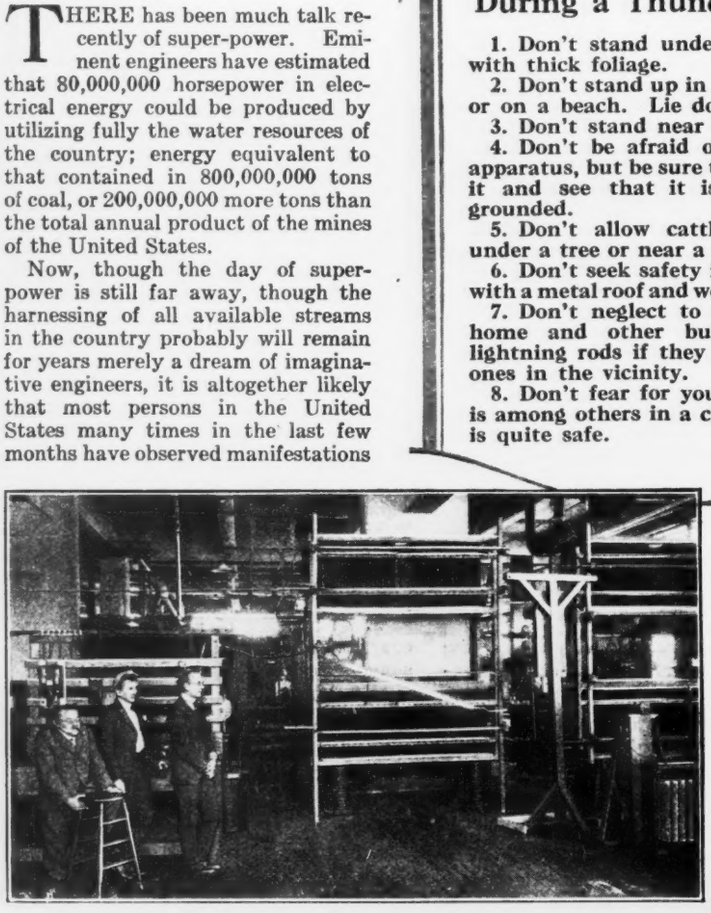
YET as a cause of death it is exceeded greatly by virtually every disease and every common form of violence. Only 425 persons were killed by lightning in the United States in the last year for which statistics are available, as compared with 1,038,952 deaths from all causes. The figures show that you are far more likely to die in a railroad wreck, to be killed by an automobile, to drown, or even to be murdered, than to die by lightning.

Science has determined further that not more than one flash in 100 actually is dangerous either to man or property, simply because only one flash in 100 reaches the earth. The rest are spectacular discharges between clouds, followed by startling roars of thunder, but so far up in the air as to be quite harmless to anything on earth.

Moreover, only a small percentage of the flashes that reach the earth actually causes damage, for lightning, like every other form of electricity, travels over the path of least resistance; and, since air is not a good conductor of electricity, lightning, when it can, leaves the air to travel to the earth over some better conductor. Nowadays it is likely to find such a conductor in the form of a lightning rod, the steel frame of a city building, a metal flag pole or a grounded

How to Avoid Danger During a Thunderstorm

1. Don't stand under a tall tree with thick foliage.
2. Don't stand up in an open field or on a beach. Lie down.
3. Don't stand near chimneys.
4. Don't be afraid of your radio apparatus, but be sure to disconnect it and see that it is thoroughly grounded.
5. Don't allow cattle to collect under a tree or near a wire fence.
6. Don't seek safety in a building with a metal roof and wooden pillars.
7. Don't neglect to protect your home and other buildings with lightning rods if they are the only ones in the vicinity.
8. Don't fear for your home if it is among others in a city block. It is quite safe.



At the left: A spectacular demonstration of an artificial lightning flash produced in the laboratory of the late Dr. Charles P. Steinmetz, world famous electrical engineer. Doctor Steinmetz is at the extreme left

An unusual photograph of a thunderstorm at sea, showing lightning flashes playing about the masts of a sailing vessel. While steel steamships are practically immune from lightning, wooden ships, especially those with masts, are places of danger

radio aerial. At such times the chances are that the lightning will prove quite harmless. Only when it finds a better conductor than the air in a man, an animal, a tree, a frame building, or the wooden masts of a ship does lightning actually cause fires or the loss of life.

MOST of the exceptionally tall structures in the world have been struck by lightning more than once, but have escaped damage because the lightning has been carried harmlessly to the ground on lightning rods. The steel Eiffel Tower in Paris, tallest structure in the world, hence an admirable target for lightning, has been struck many times without damage, despite the old adage that lightning never strikes twice in the same place. Less than a year ago a lightning bolt severed the radio aerial that stretches from the top of the tower to the ground; yet the tower itself was uninjured because of the protection of lightning rods.

The Washington Monument likewise has been struck by lightning on several occasions, but was damaged the first time only, in 1885, a year after it was built, and before adequate lightning protection had been installed.

Many of the skyscrapers in our cities have been struck, without the occupants' being any the wiser, because the steel skeletons conveyed the electricity into the earth as silently and harmlessly as electric current flows through an ordinary transmission line. Indeed, to be inside a skyscraper, or any other steel-framed building during a thunder-and-lightning storm is to enjoy security. A steel ship likewise affords safety. So does a locomotive or a railroad train.

A frame building properly protected by lightning rods likewise is a place of safety. So, to a great extent, is a building in a deep valley. Any structure in the city, where buildings are in rows, is almost entirely safe from lightning. However, you may find yourself caught out in an electrical storm some day and you will want to know how to protect yourself.

Four tremendous discharges of forked lightning, flashing across the cloud-blackened sky simultaneously, are recorded in this extraordinary photograph taken at Spokane, Wash. In each flash was concentrated many times more energy than could be produced at one instant by all the power plants in the world

Another spectacular photograph, taken at Indianapolis, Ind., illustrating how deceptive the appearance of lightning often is. Neither the building nor wires in the foreground was struck. In fact, not more than one in 100 flashes of lightning you see ever reaches the earth, and very few of these ever cause damage

ABOUT the most dangerous place in such a situation is under a tall tree with heavy foliage, especially if you are wet. The tree, a better conductor than the air, attracts the lightning, which, vaporizing its sap and other moisture into a gas, causes an explosion, resulting in serious injury or death to the person near it. Probably more people are killed by lightning in this way than in any other.

An open field, a beach, an open boat on sea, lake or river; the roof of a high building, the top of a mountain, or any other similarly exposed location likewise is a place of especial danger. In any of these cases your body is likely to form the tallest conductor in your vicinity, and consequently the object most likely to be struck.

If caught in an exposed place during a lightning storm, get under cover immediately if you can. If you cannot, you will reduce your chances of being struck appreciably if you will lie flat on the ground or in the bottom of your boat.

If indoors during a thunderstorm, stay away from chimneys. Remember that lightning always is seeking the easiest path to the earth and the column of warm air ascending through a chimney is likely to supply it. A chimney also is likely to be lined with soot—carbon—a better conductor than the air; hence the path that lightning will take if it passes near by.

There is an old tradition that it is dangerous to hold or be near any metallic objects while lightning is flashing. In the case of a wire fence, the metallic roof of a frame shed, or any metal object of similar size or larger, that is true. It is a good rule to keep cattle as well as yourself from wire fences. Much stock has been killed by huddling in fence corners during electrical storms. But to hold a penknife, a pair of shears, field glasses or an umbrella during a thunderstorm will not increase your danger.

When the present widespread interest in radio began, many persons hesitated to install radio sets in their homes lest the aerials should "attract lightning." This fear probably has been dissipated, for fire-department and insurance authorities are agreed that an aerial, equipped with a lightning arrester, constitutes no source of danger. If properly grounded, it actually will afford protection by acting as a lightning rod. If you have a radio set, be certain, though, that you disconnect it during a storm and that your aerial is grounded.

ALTHOUGH the study of lightning and its effects has enabled science to frame rules for escaping its dangers, that does not mean that you are advised to emulate Ajax and defy the lightning to strike you. Rather, it is well to recall the fate of that mythical hero and take extraordinary precautions when lightning is flashing, for lightning has a way of playing freakish tricks, often with fatal results.

(*Continued on page 120*)

Reproduced from "Galápagos: World's End," by courtesy of the author, William Beebe, and G. P. Putnam's Sons

A Survivor from the Age of Reptiles

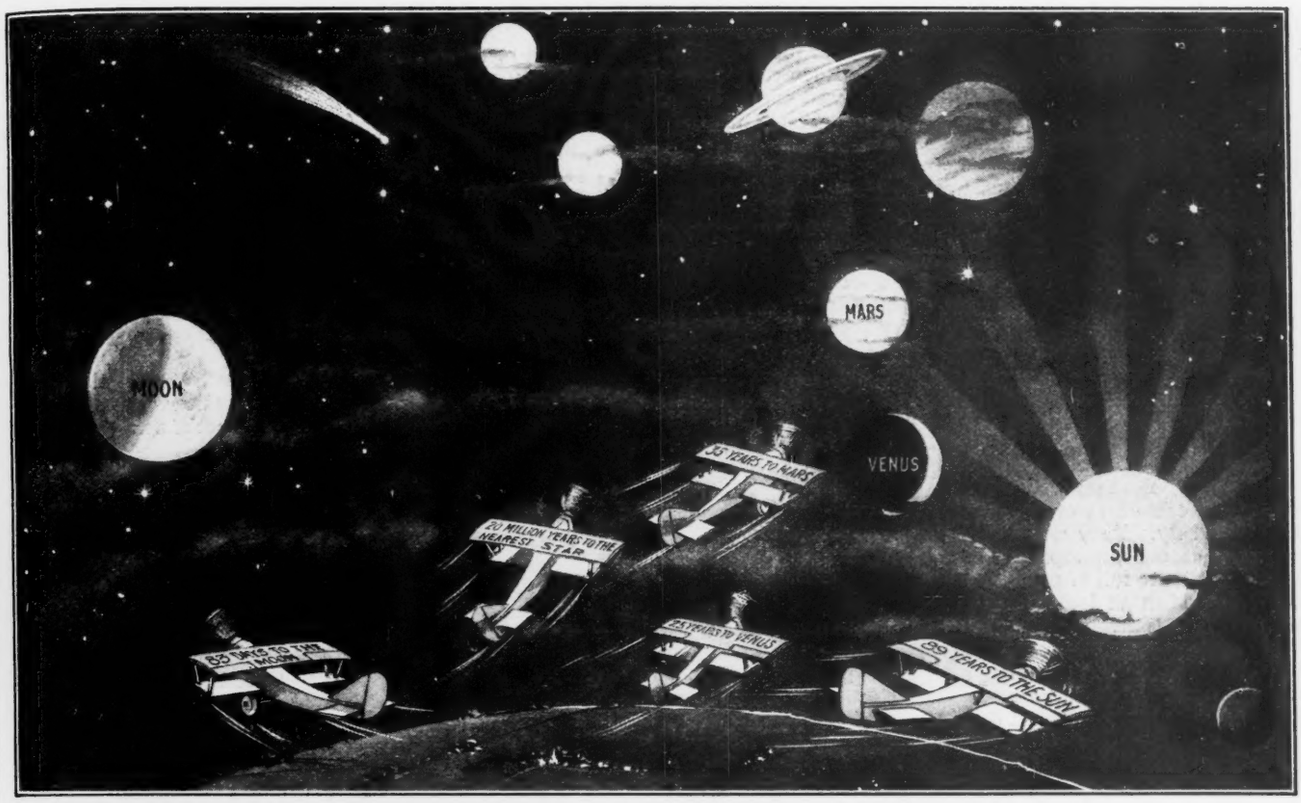
IN THE Pacific Ocean, about 500 miles off the coast of Ecuador on the equator, lies a tiny group of desert volcanic islands known as the Galápagos Archipelago—dots of barren lava land that still live in the Age of Reptiles! Here, among outlandish creatures that never have heard the voice of man, the dominant sound of life is the hiss of the sea iguana—a giant marine lizard that exists nowhere else in the world.

The close-up photograph of this great reptile reproduced above is one of the amazing records brought back from Galápagos by a recent expedition led by William Beebe, Director of the Department of Tropical Research of the New York Zoological Society. For 100 hours Mr. Beebe and his 12 fellow explorers searched islands that have been visited only by pirates, ex-convicts, and scientists. Charles Darwin visited four of the islands in 1835, and found wonderful material for his "Origin of Species."

The great marine iguana, Mr. Beebe tells us, grows to a length of four feet and looks like its prehistoric ancestors, some of which were 80 feet long. It lives about the seashore and feeds on seaweeds. At night it sleeps in a burrow of the earth, or in a lava crevice. In the daytime it comes out, and at low tide makes its way to the edge of the surf to feed.

Specimens of the iguana captured by the expedition refused all food. It was found they could live on salt water and air for more than 100 days.

"No other living inhabitant of these islands seemed so thoroughly a part of its environment," says Mr. Beebe. "In color, in rough contour, in the scales of its head standing up like volcanic cones, in its intimacy with lava and surf, it seems an organic embodiment of the shores of these desert islands."



It would take nearly 35 years for an airplane, speeding at two miles a minute, to travel from the earth to Mars; yet a radio signal could travel to Mars and back in less than seven minutes! Airplane distances to other planets, the sun and moon are indicated

Could We Decode Mars Messages?

By Lieut.-Comm. Fitzhugh Green, U. S. N.

TWENTY-ONE different methods have been suggested to communicate with Mars this summer.

Gigantic searchlights, long lines of blinking arc lamps, geometric designs in the Sahara Desert, radio impulses of various kinds, huge reflectors for heliographic signals, enormous rockets, and other forms of pyrotechnics—these are but a few of the fantastic schemes proposed.

Ordinarily Mars is between 100 and 200 millions of miles from us. But about once in 15 years she whisks by us in the night less than 36 millions of miles away. Her last visit was in 1909. This time it will be on August 22, 1924. To visualize this distance consider that an airplane flying two miles a minute would have to travel without stop for about 35 years to reach Mars, were such a trip conceivable.

Our highest powered telescopes, however, will shorten the distance visually to about 50,000 miles. This will enable astronomers to study the geography and the physical aspects of the planet's surface.

Martian geography is ahead of terrestrial geography. Though not until 1882 did we have our first map of Mars, we now know every inch of her polar regions while we are still exploring our own.

Physical conditions on Mars are fairly well known. By the spectroscope we have learned that her atmosphere contains but the slightest traces of water. This fact is confirmed by absence of clouds about her. Everlasting ice-caps at her polar regions depict terrific cold. Shrinking of these caps toward Martian summer is taken as a sign of melting. That the canals, or dark lines running southward, darken progressively at this time supports the belief that these lines are vegetation bordering artificial or natural canals.

ON AUGUST 22 the planet Mars will be within 36,000,000 miles of Earth—closer to us than it has been for a century.

Is Mars inhabited? If so, are her people trying to signal us even now? Are those annoying interferences that break in on your radio really interplanetary messages? And if so, will men ever be able to decode them?

Commander Green, who was one of America's code experts during the war, tells here the reasons why he believes we eventually shall be able to communicate with the Martians, if such messages are sent. He points out that with the recent advance in radio our chances of "getting" Mars are 10,000 times better now than 15 years ago, when the planet last passed close to Earth.

BUT there is still much to learn: Why are there no lakes, rivers, or seas on Mars? Why are her snows yellow? What is the effect of her having seasons twice as long as ours? Why are her surface features nearly all straight lines? Why do these lines double from time to time? What are those queer shadows that sometimes steal across her face? These are some of the questions astronomers hope to throw new light upon this summer.

If Mars is inhabited, her people may answer some of these questions for us before long. They may be signaling us even now. Since on August 22, Mars will be millions of miles closer to us than she is ordinarily, and, in view of the tremendous progress lately made in radio, our chances for receiving such signals are at least 10,000 times better than they were when she passed us in 1909.

THE theory of the existence of a Martian race is not unreasonable. Biologists and chemists lately have stripped much of the mystery from that phenomenon we call "life." Results of their research show beyond a doubt that only a few requisites are necessary to life. They are: warmth, light, water, carbon compounds, and some inorganic salts. Every one of these we know exists on Mars.

Camille Flammarion, the great French astronomer, quite vigorously asserts that there are people on Mars and that ultimately we shall communicate with them as readily as we now communicate with remote portions of our earth's surface. He concedes that conditions there are inhospitable. But, he adds humorously, two fish conversing never would admit that any one could live on the banks of their stream, for "life out of water would be impossible!" As bearing on the persistence of life, it is interesting to recall that British antarctic expeditions have found small creatures frozen solid in the glacial ice of the south polar ice-cap. Few of the creatures failed to revive when thawed out.

If a race of reasoning beings does exist

on Mars, its characteristics are not likely to be similar to our own. The reason for believing this is that Mars probably was habitable while the earth was still a ball of fire.

Mars is very much smaller and much farther away from the sun than we are. Therefore she must have cooled off ages before the earth did.

HENCE, life may have started there millions of years before it started here. And daily, the Martians, if such there be, have seen sparkling in the sky their neighbor planet, our Earth.

It is not far-fetched to endow such a race with curiosity. They, too, must yearn to know what lies across the pit of space. Yet they would not try to come here even if they could fly. They would realize that our atmosphere is so much more full of moisture that a Martian doubtless would drown in it.

No, the Martian's efforts would be concentrated on communication. Each time his world swept close aboard us, he would discharge every known form of ether wave in our direction in eager hope we might respond.

Imagine that some night in August or September, while you are comfortably enjoying an evening concert with your home set, suddenly and rudely there breaks in upon the soft *aria* a clear and bell-like note. Angrily, under your breath, you curse all amateur experimenters.

The note breaks off. A little later it comes again, this time in groups of dots and dashes. And again, out of patience, you give up, switch off, and sit down to write a red-hot protest to your favorite radio editor.

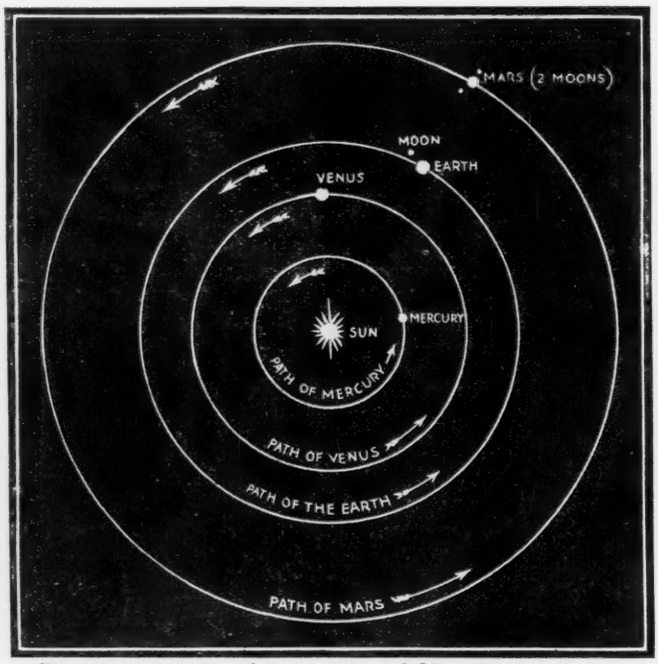
Morning finds you still a-grumble. You unroll the daily paper. Your jaw drops. *"SIGNALS FROM MARS!"* scream the headlines. *"Experts unable to trace strange radio interference. Little doubt that Martian inhabitants are trying to communicate with Earth!"* And later it proves to be true. What then?

Most people think we should call upon our code and cipher experts at once to read the strange messages. Unfortunately such aid would amount to little. Deciphering Martian signals would be a problem absolutely different from that of deciphering code messages. For while the inhabitant of Mars may be a two-legged, reasoning creature like ourselves, his mental experience and his mode of conversing among his own kind may be totally different from anything we ever have known. We have no right to assume any more about Martian signals than that the Martians have *ideas*, just as we have; and that these ideas are traded back and forth by some system of *symbols*.

MAN'S early experience in written and spoken language is illuminating. The Neanderthal man drew a picture of a saber-tooth tiger on the wall of his cave to signify that he had a successful hunt. Between that rough, primeval sketch and our modern euphonious printed record of Roosevelt's African exploits yawns a vast chasm of unwritten human history.

The Cro-Magnon man, meeting a stranger, held up his right hand empty of weapons to signify the friendly spirit of his heart. Between that ancient gesture and our stiff modern military salute, which has descended from it, spread uncounted ages of changing human customs and mental habits.

These examples from our own known story of earthborn life suggest vividly the incredible difficulty of guessing with any accuracy what sort of language a Martian people hundreds of thousands of years older than we and living for ages in a totally different environment might have.



This chart shows the relative positions of Mars, Earth, and other planets with regard to the Sun on August 22, when Mars comes within 36,000,000 miles of us—closer than it has come for a century

THUS, no matter how passionately we may long to plunge into sociable conversation with Mars when once her signals reach us, or ours reach her, the development of an intelligible code will be a slow, heartbreaking task.

Starting, as we shall have to, with the simple *symbol-idea* notion, we shall find ourselves at once in the realm of the cryptographer, the scholar whose business it is to translate ancient inscriptions. In many ways his problems are very similar to those we shall face in reading Martian messages.

Early ideographic or picture writing was worked out on the principle of the caveman's drawings. Subsequently abstract ideas were introduced by suggestion. Thus abstract *death* once was put into writing by a symbol consisting of a human head in a horizontal position with closed eyes. Likewise abstract *life* was denoted by the same head placed vertically with its eyes open. In the course of time the lines necessary to delineate the skull and features were greatly simplified. Eventually the symbol did not look like a head at all. That is the way some letters of our alphabet originated.

Earth-Mars communication must be studied from the point of view of two intelligent and reasoning cavemen who have met in the primeval forest and are determined to exchange ideas. What would two such strangers talk about?

The only things they *could* talk about, or, putting it more accurately, make signs about, would be experiences common to both, such as food, drink, fire, fear, and mirth. And if the two men were very intelligent and very much determined to converse, we may picture them exchanging real thoughts in the space of an astonishing short time. (The writer has gone through exactly this experience with the Eskimos of a north Greenland tribe.)

Now what experiences are common to an Earth man and a Martian?

There are many of them. Night and day, for instance; winter and summer; heat and cold; eclipses; sun, stars, comets, meteors, moons (Mars has two), and so on. Once these features have become mutually identified by sending radio or some other sort of signals to correspond with each, we may then advance to abstract *ideographic* signals. For example, our signal standing for *comet* might ultimately come to mean *swift movement*, just as in English the word *star* has come to mean abstractly *some one who shines out in the firmament of human endeavor.*

That there would accrue to us immense profit from communication with Mars never has been disputed. Our scientific knowledge might be advanced thereby thousands of years. Martian telescopes must have enabled them to study our meteorology for many centuries. Hence, with their aid, weather prediction here no doubt would become with us an exact science.

The fact that a light ray or radio signal could be reflected back from the surface of Mars in less than seven minutes from the instant of its earthly emission, would make it possible to study such phenomena in a way impossible on earth alone.

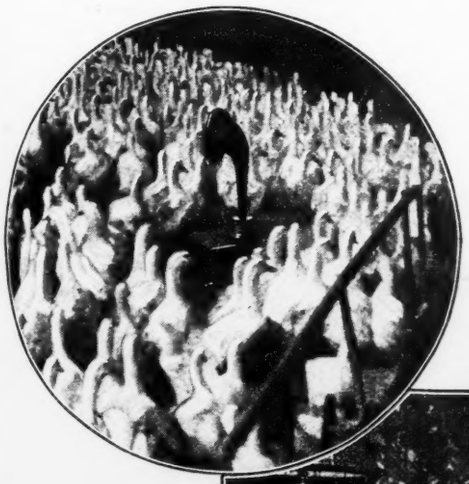
If we could learn first-hand how the Martian surmounts his unhappy handicap of almost universal aridity, we might reclaim our great Western deserts cheaply and quickly.

IN CONCLUSION, we repeat that if Mars is inhabited and her people are actually trying to signal us, our chances of "getting" her this summer are 10,000 times what they were in 1909.

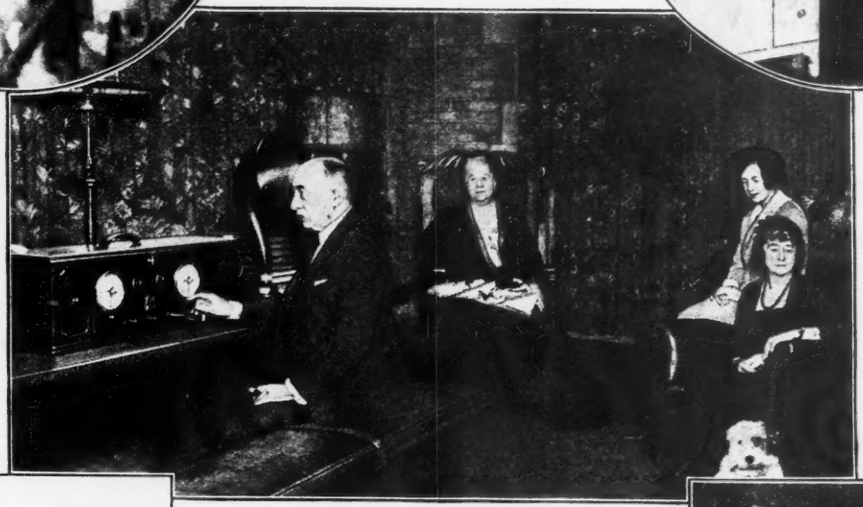
Think what radio progress we have made! In 1910 Marconi opened his transatlantic service. In 1913 we mastered wireless communication with speeding trains. In 1915 we connected Washington with Paris and Honolulu by telephone. By 1921 public broadcasting stations were opened. Now the world is girdled with invisible sound!

What a thrilling event that first signal from Earth to Mars would be! *The most momentous episode in history!*

Every Day Brings Something Novel in Radio



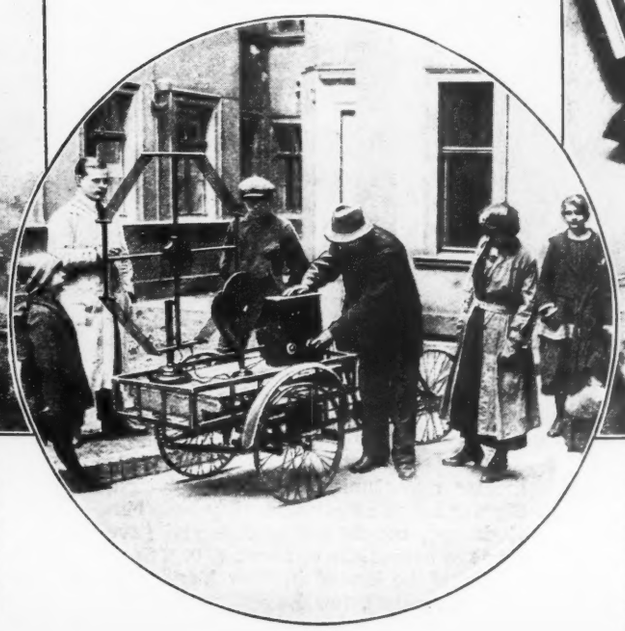
Radio still is a fascinating novelty, constantly finding odd uses in unusual places. Meanwhile it has established itself firmly as an almost indispensable part of American home life. Below is a scene in the Washington home of America's foremost mining engineer, John Hays Hammond, who with his family enjoys the evening radio programs of music, entertainment, and news reports



An odd radio audience. A loudspeaker entertains hundreds of ducks and geese at dinner-time on a large poultry farm at East Moriches, L. I. The owners say the fowls are fascinated by the music and voices from the big horn

The time-honored household cookbook is giving place to radio recipes these days. The picture above shows Miss Lucille White in her kitchen at Chicago, Ill., taking down a radio recipe as it is broadcast from a New York station

An unusual "organ grinder" has made his appearance on the streets of Berlin, Germany. Instead of turning out music with a crank, he turns the dials of a sensitive receiving set that brings in broadcast concerts by means of a loop aerial, entertaining street crowds through a loudspeaker. The entire receiving apparatus is mounted on a specially constructed pushcart, as shown in the picture below



Saint-Gaudens' famous bronze statue of Diana that surmounts the tower of Madison Square Garden in New York City soon may become the world's most unusual radio antenna. Radio engineers are now considering the feasibility of using this famous statue as an aerial

To break the monotony of weary hours of vigil, this canny night watchman in London, England, tunes in his radio set and listens to the latest in operas, concerts, and lectures. With his set he claims to have heard messages from Pittsburgh, Pa., relayed by British broadcasting stations

The Swiftest Traveler on Earth

A Dramatic Story of Applied Science at Three Miles a Minute

By Fritz Blocki

A LITTLE more than 30 years ago one of the many blue-eyed lads in the ancient Norse town of Trondhjem, about halfway up Norway's long Atlantic coastline, yearned boyishly for a luxury that few men hoped to enjoy at the time. The lad dreamed of owning a bicycle. His parents laughed at him, said such a thing was far too expensive, and that Trondhjem and the surrounding country were much too hilly for such a costly contrivance to be of any use.

There were a few other bicycles in town, however, and the lad's determination would not let him rest until his craving for a bicycle was fulfilled. So he collected and sold all his worldly knickknacks, did odd jobs for spare change, and finally astonished his family by lugging homeward triumphantly the bulk of a bicycle sadly in need of repair.

"All it needs is a little fixing up," he announced happily; but when that fixing up was nearly completed, he found to his dismay that all the ball bearings were missing.

Not to be outdone, he carved a set of ball bearings by hand out of weathered oak knots, soaked them in oil to harden them, and soon he was the proud possessor of a bicycle that not only ran, but ran so well that he challenged and beat nearly every one else in town.

"Sig" Haugdahl, world speed king. The cigar, he says, serves as a "cushion for his teeth" as his racing car thunders along

THE name of this determined lad was "Sig" Haugdahl, known about Trondhjem as "Sig the Racer."

Today the same blue-eyed lad, grown to manhood and an American citizen, is the speed king of the world, the creator and possessor of the fastest car in existence, the "Three-Miles-a-Minute Wisconsin Special" with which he has attained the phenomenal speed of 180.27 miles an hour, or more than three miles a minute. This is the fastest that any man ever has traveled over land or water, faster than the speed of most airplanes.

Haugdahl holds all the world's speed records from one to 10 miles, and has more dirt-track records to his credit than any race driver today. In the last season he established more than 20 new dirt-track marks, two of which were world records.

The story of his rise to supremacy among the "knights of the roaring road" is as spectacular as was the winning of his first lesson in mechanics back in his seaport home.

Shortly after the bicycle episode, Haugdahl's fancy sped across the sea to America, where he knew he had an uncle somewhere in Minnesota. To his parents' dismay he announced he was going to set out to find his uncle and with only enough change in his pocket to reach halfway to his destination.

Nevertheless he boarded a train and finally made his way to Minneapolis, "broke" but happy. After a day and a half of ceaselessly tramping the streets, he located his uncle, who put him to work in his butcher shop.

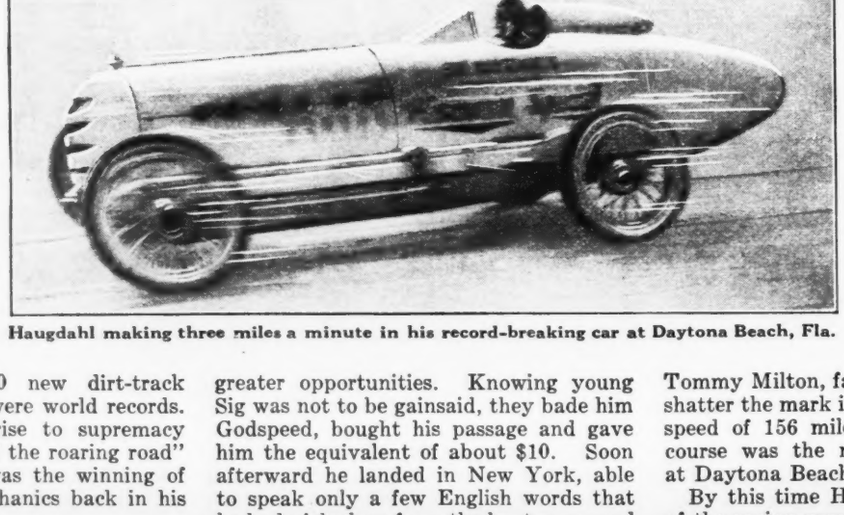
But tying up pork chops and weighing out hams was not to Sig's liking. He wanted something mechanical, something speedy. So his uncle sent him to work in a carbide-lamp factory in the town of Albert Lea, Minn. Sig went with joy in his heart and stuck at his new task until he had mastered the small factory and all its machinery.

WHILE at Albert Lea, Haugdahl became acquainted with a new type of bicycle—the motorcycle. It was not long before he saved enough to buy what was little more than a wreck of what once had been a two-wheeled machine. The gasoline engine was new to him, so he set out to master its intricacies by practically rebuilding the machine with the avowed purpose of making a racer out of it.

At the first opportunity he entered his rebuilt creation against professional racers and made a creditable showing. Thus began his career as a speed king.

HAUGDAHL stuck to motorcycle racing until he had established the mark of 103 miles an hour—a record at the time—and had further demonstrated his extraordinary staying powers by riding out one race with a broken leg resulting from a spill on the back stretch.

After recovering from this accident Haugdahl decided four wheels would be safer than two when flirting with death at high speed. So he entered the auto-racing game, first as mechanic, later as driver. Meanwhile the world speed marks advanced from a mile a minute, which for a long time was considered an enormous speed, to 100 miles an hour, which was thought to be unbeatable.



Haugdahl making three miles a minute in his record-breaking car at Daytona Beach, Fla.

It remained for Tommy Milton, famous speedway ace, to shatter the mark in a Duesenberg car at a speed of 156 miles an hour. The race course was the natural sand speedway at Daytona Beach, Fla.

By this time Haugdahl was a veteran of the racing game. He knew cars, their

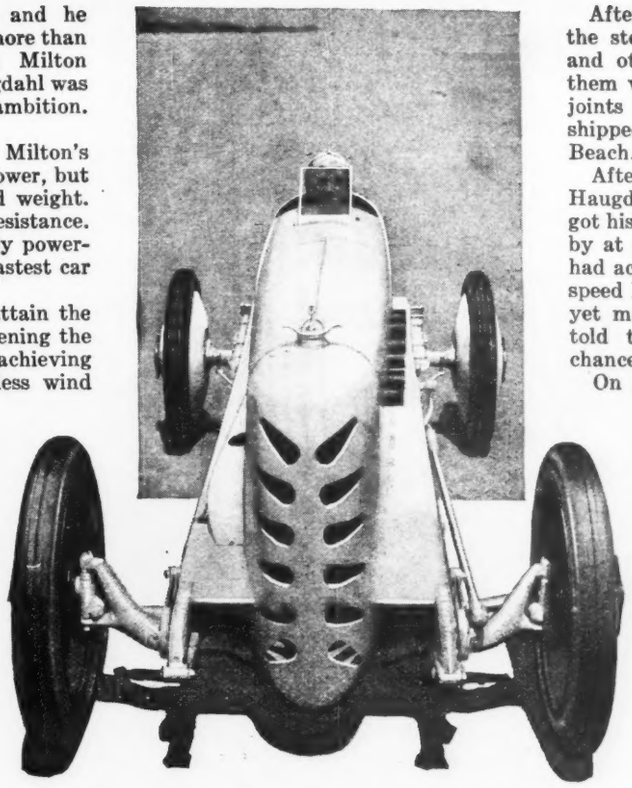
greater opportunities. Knowing young Sig was not to be gainsaid, they bade him Godspeed, bought his passage and gave him the equivalent of about $10. Soon afterward he landed in New York, able to speak only a few English words that he had picked up from the boat crew, and

defects and their possibilities, and he dreamed of attaining a speed of more than three miles a minute. When Milton attained 156 miles an hour, Haugdahl was sure he could realize his great ambition.

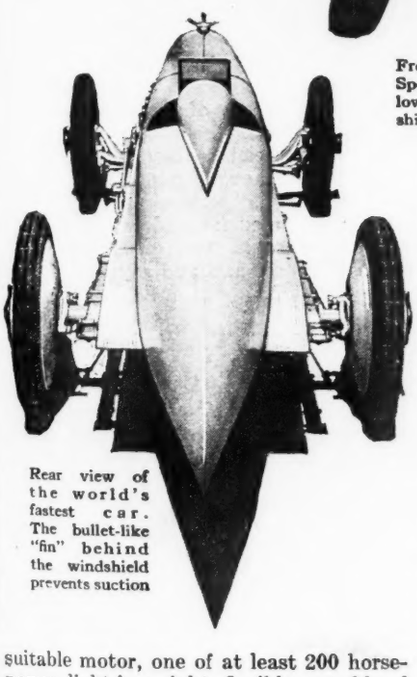
HE STUDIED the layout of Milton's car. It had the necessary power, but paid for this power in increased weight. The bulk increased the wind resistance. It was well balanced, enormously powerful, wonderfully built, and the fastest car in the world at the time.

Haugdahl's problem was to attain the power of Milton's car while lessening the space occupied by the motor, and achieving less weight, less body width, less wind resistance, and perfect balancing. He went to Florida to see Milton's car, and there he found the solution quite by accident. While boating in the Gulf, he saw a huge fish glide by like a flash, with no apparent resistance to the water. The fish had solved the problem of resistance. Why not he? He started north immediately, and designed the body of his car with the fish as his model.

The next thing to find was a suitable motor, one of at least 200 horsepower, light in weight, flexible, capable of attaining enormous speed and standing enormous strain, one that would fit under a very narrow hood and that could be used with a narrow radiator, without overheating. After a long search he finally found a Wisconsin hydroplane motor, originally turned out for government use in a flying boat. It looked as if it might do, so he bought it and shipped it to Albert Lea, Minn. There he secreted himself for 11 months in his workshop.



Front view of Haugdahl's "Three-Miles-a-Minute Wisconsin Special," showing the extremely narrow, streamlined and low-slung body, with rounded nose and tiny, slanting windshield. A fish seen in Florida waters served as his model



Rear view of the world's fastest car. The bullet-like "fin" behind the windshield prevents suction

THE difficulties that Haugdahl surmounted in those 11 months of night-and-day toil never will be fully recorded. Many changes were required before the engine would fit into the small space Haugdahl determined would have to be sufficient if he were to nullify wind resistance. The hanging of the engine had to be changed. The suspension of the body had to be determined to the smallest fraction of an inch. The oiling system had to be made more compact, yet with increased capacity. The water circulation system had to be adapted to a smaller radiator than was originally intended for a motor of that size. Rods, axles, every exposed part had to be beveled and set to cut the wind.

ONE by one Haugdahl solved these difficulties, most of them before the car ever turned a wheel. The body he hammered of sheet steel by hand. He made it only 20 inches wide at its widest part, at the driver's seat, just behind the low-hung engine, and 16 feet long. His oil-reserve tank he placed back in the body of the car instead of above the engine, and the oiling system pressure he increased to the maximum.

He also made all the water connections oversize to allow the freest possible circulation. The radiator, especially designed, was only 18 inches wide, with a fishlike fluted nose, offering a minimum of wind surface.

The body itself was a continuous streamline affair, built like the fish he had seen in Florida, with a thin, bulgeless body, tapering into a knifelike tail that was fully inclosed at the bottom to prevent air suction at high speed. At the top, where Haugdahl's head would have to be when driving, he erected a small slanting windshield, about six inches wide, nine inches long and four inches high, of thick plate glass.

To close the vacuum that might be caused behind this little raise of glass, he added a bullet-like miniature tail just back of his seat.

After beveling the reach-rod connecting the steering knuckles on the front axle and other exposed parts, then covering them with tape and covering all outside joints with leather jackets, he quietly shipped the fishlike creation to Daytona Beach.

After a day or two of adjusting, Haugdahl told the judges he was ready, got his curious machine going, and flashed by at a speed of 161 miles an hour. He had achieved one of his ambitions—to be speed king of the world! But he had not yet made three miles a minute. So he told the judges to give him another chance.

On April 19, 1922, after a few minor changes, he again flashed over the electrically timed natural speedway at Daytona Beach at the amazing speed of 180.27 miles an hour, or more than three miles a minute, covering a mile of ground in 19.97 seconds —faster than any other man ever had traveled on land.

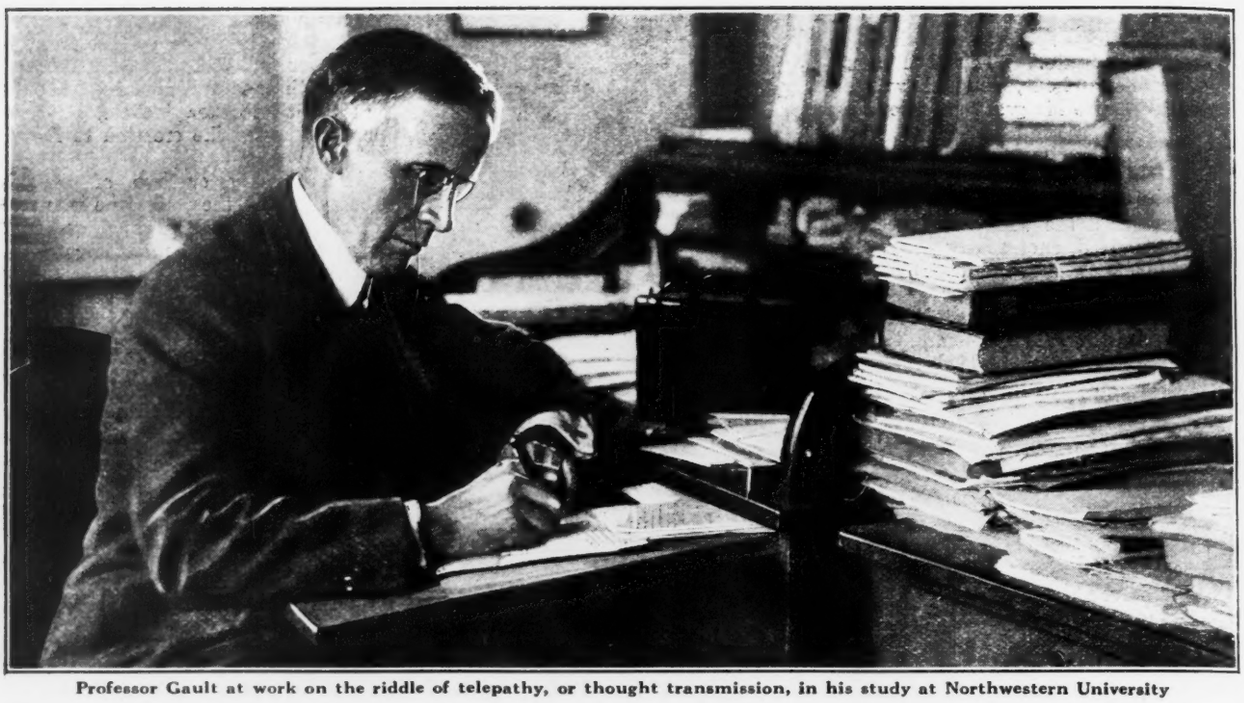
NOT content with that, he established further records in all distances up to 10 miles. Thus, starting with little more than a hobby for mechanics, perseverance, and an inordinate craze for speed, he had accomplished, practically single handed, what others with unlimited resources had been unable to achieve.

Yet he was not satisfied. With the world records for the straightaway in his possession, he set out to chalk up a new set of dirt-track records. This he has succeeded in doing with his car exactly the same as it was on the Florida beach except for a slight change in the gear ratio for mile and half-mile tracks.

The power plant that made these achievements possible is a six-cylinder hydroplane engine built mostly of aluminum and weighing only 600 pounds. It has a piston displacement of 756 cubic inches and in spite of this great displacement turns more than 2000 revolutions a minute. The motor is geared at a ratio of $1\,{}^{2}/_{5}$ to one directly to the rear axle, doing away with clutch and transmission. Thus the engine can be run only when the car is on a race track. The compression is so great that it cannot be cranked. Four men are necessary to start the car by pushing it. With the engine throttled down, the car "idles" along at 35 miles an hour.

THE engine hangs so low that the ground clearance is only three inches. The driver's seat and the opening in the body above it is so small that only the diminutive Haugdahl, who stands five feet four inches in height, can get into it. The weight of the entire car is less than 2000 pounds.

The driving strain at the terrific speed the car develops is so great that Haugdahl carries a cigar in his mouth as a "cushion for his teeth." One time he forgot that his cigar was lighted. When speeding at "only" about 120 miles an hour, he turned his head slightly. The wind blew the cigar into a flame and burned it to his face in an instant nearly causing him to wreck the car.



Professor Gault at work on the riddle of telepathy, or thought transmission, in his study at Northwestern University

Telepathy Put to the Test

By
Robert H. Gault, Ph.D.

IS THERE really anything in telepathy, or mind reading? Is there any scientific basis for believing, as many of us do, that one man can communicate his thoughts to another merely by wishing to do so?

The unusual experiences that have come to most of us—the utterance of a thought at the precise moment that the same thought is put into words by another; the unexpected telephone call from an almost forgotten friend momentarily in our thoughts—can these be traced to transference of thought, or are they, as many insist, only coincidences?

Not long ago a group of scientists headed by Professor Robert H. Gault, eminent psychologist of Northwestern University, and Professor Gardner Murphy of Columbia University, conducted by radio what probably was the most extensive experiment in telepathy ever made. The results of the test and of other novel experiments are presented here by Professor Gault in an absorbing article that sheds new light on what has been—both to the scientist and the layman—a profound puzzle for centuries.

MOST of us have heard stories of the father and mother who have lived together for 40 years and who, one evening as they sit under the reading-lamp, engage in the following conversation:

"Wonder if John won't come home this Christmas and bring Mary with him," remarks the father.

"Why, I was just thinking the very same thing!" comes the response from over the knitting needles.

Such an incident often passes as evidence of thought transference by the mere energy of thought, or telepathy. But is it necessary to interpret the case in such a way?

Remember that the father and mother have passed many winters and many evenings together in the living-room by the reading-lamp; that during all these years the evening has been the time for thinking of absent members of the family and the time of leisure for speaking of them. Furthermore, it is near Christmas—the time for thinking of young folks coming home. Considering all these circumstances it does not require a great stretch of imagination to interpret the simultaneous expression of the same thought as a coincidence; a coincidence, to be sure, that has been conditioned by the habits, mental set or disposition of a lifetime.

The fact that in ninety-nine of a hundred cases stories of this kind are accepted as evidence of thought transference indicates a certain slovenliness in method of observation. For example, who ever took the precaution to *assure* himself that it was exactly at a particular moment that he thought of John and Mary? The good mother at her knitting may have thought of the possible Christmas homecoming some minutes before her spouse spoke up, but at the moment of utterance the thought seems to have been simultaneous, and so it is uncritically described as a case of telepathy. Such is the illusory trick of memory.

A MUCH more striking illustration of what passes for telepathic communication is discovered in the professional who finds objects that another has hidden and who obeys "mental" commands. Many such persons perform really astonishing feats. They believe in all honesty that they are genuine telepathists, and any number of cool-headed observers believe implicitly in the claims they set forth.

I have in mind a telepathist of the sort who has demonstrated far and wide. I shall describe two of his performances and add my interpretation.

I FIRST met him in company with several other men in a downtown club. When my opportunity came to put him to test, I selected a series of "mental" commands that I would give him. They were known only to myself. "Go to the desk"; "Take a match from the box"; "Carry the match across the room to the little table upon which are a water pitcher and two inverted tumblers"; "Turn up one of the tumblers"; "Place the match inside it"; "Shake it about"; "Remove the match from the tumbler"; "Leave the tumbler in its place and carry the match over to the telephone stand in the corner of the room"; "Place the match upon the stand beneath the telephone instrument."

These commands I "thought" one after another, never passing on to a new one until the preceding one had been obeyed.

The telepathist walked from place to place in the room and I followed at a distance of two or three feet behind him.

During the entire test he exhibited a set, intent facial expression except for a somewhat sleepy look about his eyes. No questions were asked and not a word passed between us until the test was completed. I alone of all the men in the

(*Continued on page 114*)

"Man's Most Terrible Invention"

By Frederic Mortimer Delano

STORIES of mysterious rays capable of stopping automobiles, bringing down flying airplanes, killing men and other destruction have come from many parts of the world in the last few months.

A dozen or more inventors have announced the discovery of means for transmitting electrical energy in any direction without the use of intermediate transmission wires. While admitting the scientific possibility, most experts have been frankly skeptical and others have openly ridiculed the claims of the inventors.

But the idea of a malignant electrical charge with the speed of lightning, which can kill men and shrivel up airplanes in flight, and interfere with the working of gasoline engines, has caught popular imagination. There is to such a thought something of the thrill that H. G. Wells, some 30 years ago, imparted to his book, "The War of the Worlds," when he described the descent of weird beings from Mars armed with mysterious engines to direct beams to destroy the earth and shrivel its people to death.

AND as a curious public speculated, the numbers of inventors claiming such rays swelled. Widespread doubt and the mystery with which the inventors have surrounded their discoveries seemingly have served to augment, rather than allay, public interest.

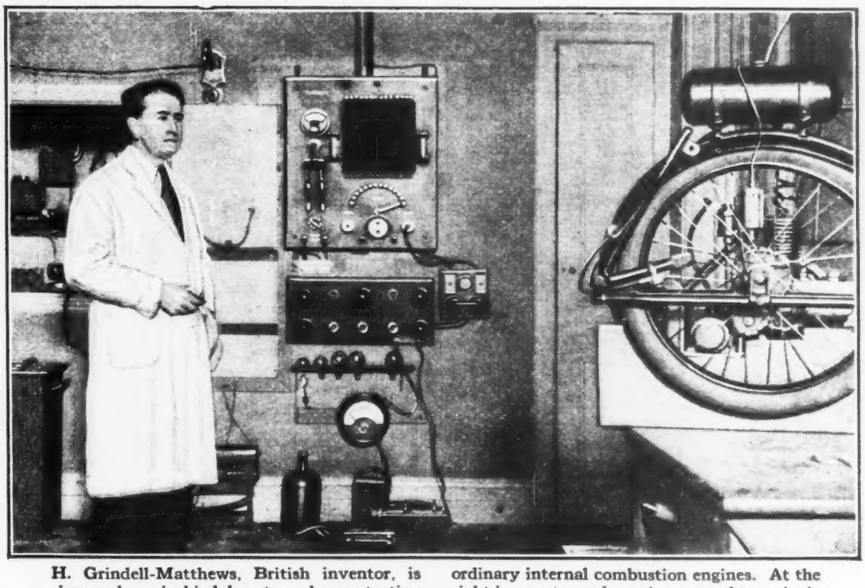
Herr Wulle, "chief of the militarists" in the German Reichstag, informed that body that his government had a device that would bring down airplanes, stop gasoline engines and "spread a curtain of death." Trotzky investigated the potency of a ray invented by Grammachikoff, and the British Air Ministry has aided a similar invention being developed by Prof. T. F. Wall of Sheffield University.

A Parisian engineer offered to demonstrate his ability to stop the engines of automobiles running on the open street. A similar claim was put forth by a German at the radio station at Nauen, while a second French inventor has succeeded, it is said, in exploding charges of powder by a beam at a distance of several feet.

But more than any other, the claims of the British inventor, Mr. H. Grindell-Matthews, have attracted wide attention. His remarkable experiments have been witnessed by scientists, journalists, and government officials. There seems little doubt that he actually has succeeded in transmitting a substantial quantity of power over distances of a few feet without wires or other conductors.

Further, he claims to be able to stop the operation of ordinary internal combustion engines, such as those of automobiles or airplanes, even without projecting any destructive force toward them. He asserts that the special ray or beam he uses for the purpose of power projection serves, even when uncharged with power, as an efficient paralyzer of the ignition systems of gasoline engines.

At the request of the editor of POPULAR SCIENCE MONTHLY I went to London to interview Mr. Grindell-Matthews. Let me describe the four experiments I saw him carry out in his laboratory.



H. Grindell-Matthews, British inventor, is shown above in his laboratory demonstrating the "mystery ray" apparatus with which he claims he can transmit power without wires or other conductors, and stop the operation of ordinary internal combustion engines. At the right is a motorcycle engine, geared to a single revolving wheel. In his experiments, Grindell-Matthews stops this engine simply by turning his invisible ray on the magneto system

AT ONE end of the laboratory is an ordinary motorcycle engine attached to a single wheel, like the rear wheel of the motorcycle. Engine and wheel are mounted so that the wheel can revolve and the engine can operate just as in a moving motorcycle on the road. At the other end of the room is the generator for the new ray. Mr. Grindell-Matthews adjusted the generator and started the engine.

At a given signal he turned his invisible ray on the magneto system of the barking engine. Instantly the explosions stopped and the engine began to slow down. Mr. Grindell-Matthews turned off his ray; the engine started up again. This was repeated; the signal being given each time by one of the observers, precluding any possibility of prearrangement of times of starting and stopping the engine. Ample opportunity was given those present to examine the engine for concealed connections or other attempts at fraud.

THE second experiment was the explosion of gunpowder by the ray. A little powder was placed in a dish at one end of the room. When the ray was turned on it from the other end of the room, the powder instantly ignited.

In the third experiment an ordinary electric-lamp bulb was attached to two wires and these wires were held by two persons, thus suspending the lamp in the air and at the same time keeping the persons who held it at a safe distance from the path of the ray. When the ray was turned on, the lamp glowed as brilliantly as though the current

Dramatic Possibilities that Lie in the "Mystery Ray"

WITH something akin to horror, men and women have discussed recent reports of inventions of "diabolic rays" powerful enough to leap out and slaughter thousands of human beings.

When the astonishing claims of Mr. Grindell-Matthews, British inventor, were announced, POPULAR SCIENCE MONTHLY sent Mr. Frederic Mortimer Delano, an able and capable investigator, to London to interview Mr. Grindell-Matthews.

Mr. Delano's report on the invention that aroused three nations begins on this page. It is an exclusive, fascinating, first-hand description of the remarkable experiments he witnessed.

POPULAR SCIENCE MONTHLY, in common with many leading scientists of the world, is unwilling at present to affirm all of the claims made for the several "mystery rays." However, it is generally admitted among scientists that such a ray is at least a scientific possibility.

Whether Mr. Grindell-Matthews and the other workers in the field have, or have not, overcome the many practical obstacles in their way, certainly they have suggested a possible method of transmitting power without wires.

In a vivid, understandable way Mr. Delano points out the possibilities of such a suggestion.

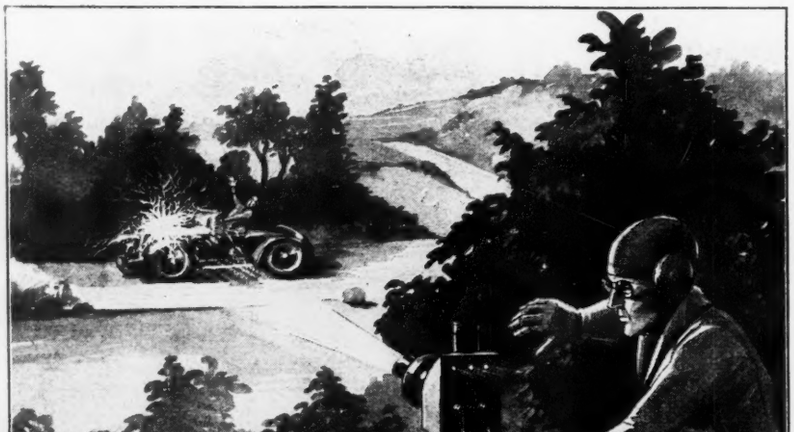
were passing through it in the ordinary manner.

The final experiment was designed to show the death-dealing properties of the ray toward living creatures. A live mouse was placed in a cage at one end of the room. The ray, now made visible to facilitate a direct hit and appearing as a thin pencil of lavender-colored light, was trained for an instant on the mouse. Instantly the little creature stiffened and died, with all the symptoms of violent electric shock.

THESE are the actual experiments performed by Mr. Grindell-Matthews; not once but many times. Disinterested and competent witnesses have observed all of them.

Mr. Grindell-Matthews does not disclose the exact way in which this remarkable ray is produced. He does say, however, that the secret lies in what he calls the "carrier beam" along which the power is projected. Previous investigators have attempted to project actual beams of heat waves or beams of electric waves similar to the waves used in radio. Mr. Grindell-Matthews does not claim to do this. His device, he says, is a beam of special vibrations of secret nature, a beam that does not constitute the power, but merely provides a path along which the power can be sent.

It is as though you reached out with a wire and touched the victim. The special carrier beam is a conductor of electricity, just as a wire is. Along this beam passes a high-voltage, low-frequency electric current. It is this current, Mr. Grindell-Matthews says, that killed the mouse, set fire to the powder, and lighted the lamp.



How the perfection of a power ray eventually might be used to halt a distant motor-car by killing its engine, and to deal electric death to the occupants of the car

This diagram shows the method by which a special carrier ray, even when uncharged with power, paralyzes the ignition system of a gasoline engine. The ray causes the space around the magneto windings to become conductive of electricity, and the current leaks between the primary and secondary windings, causing a short circuit. As a result, sparking ceases at the spark plugs and the engine immediately dies

THE power-carrying beam can be directed also against an engine magneto, but its effect, it is claimed, will be destructive, not paralyzing. The electric power in the beam will burn up the windings. For a mere paralyzing effect the carrier beam is projected alone, without power in it. Since this beam is a conductor of electricity, whenever it impinges against the windings of the magneto, it makes conductors of the spaces around these windings. The coils are temporarily short-circuited. The magneto ceases to operate.

For actual destruction—that is, when the carrier beam is charged with power—it is necessary to provide a ground connection for the object to be destroyed, as, for example, the exploding powder. The conducting carrier beam is only one side of the circuit. The electric current that flows out along the beam enters the object that the beam strikes, say the powder, and flows thence to the ground. The complete circuit, providing for the return of this current to the generator, is made by the earth, as in the old-fashioned one-wire telegraph systems.

In actual use the carrier beam is generated first, in an apparatus the construction of which Mr. Grindell-Matthews refuses to describe. From this apparatus the carrier beam escapes through a lens, much as does the beam of a searchlight or a magic lantern. After the carrier beam has left this lens, the power-carrying electric current is superposed on it.

Indeed, Mr. Grindell-Matthews states, the conductivity of the beam for the low-frequency electric current is greater if the beam also carries at the same time a high-frequency current. Accordingly, *two* separate electric currents are added to the beam, each by a special generator. One of these is high frequency; the other is low frequency. The latter carries the power.

The carrier beam itself may be made either invisible or visible, as desired. The visible ray is useful at times when one wishes to trace the path of the ray or to know just where it is impinging against a distant object. The principle is the same as in the use of tracer bullets for a rifle or a machine gun.

Though Mr. Grindell-Matthews has refused, as yet, to disclose the exact nature of the carrier beam that is the essence of his invention, it is possible to make some guesses about its nature, and European scientists have not failed to make these guesses. The prevalent opinion is that the beam is related in some way to ultra-violet light. When questioned, Mr. Grindell-Matthews denies that his beam is ultra-violet light, but the fact remains that ultra-violet light would do about what Mr. Grindell-Matthews says that his carrier beam does do. It would make the air in the path of a beam more or less a conductor for electricity.

ULTRA-VIOLET light does this by what is called "ionization" of the atoms of gases in the air. This ultra-violet light, you remember, is merely a variety of light the waves of which are extremely short, much shorter than the waves of ordinary light. It is invisible to the human eye, but it does affect the photographic plate, and it has many other chemical and physical effects well known to the scientists.

Air consists, in the main, of a great number of atoms of two gases — oxygen and nitrogen. These atoms, like all other atoms, are composed of a number of electrons revolving around an atomic nucleus, much as the earth and the other planets revolve around the sun. In the atom of nitrogen there are seven of these planetary electrons; in the oxygen atom there are eight.

IN ORDINARY air these atoms are quite stable and do not carry any unneutralized charges of electricity. Accordingly, air is not a conductor of electricity. but whenever a beam of ultra-violet light strikes against an atom of oxygen or of nitrogen, one of the planetary electrons may be driven entirely out of the atom. The nitrogen atoms of the air lose one of their electrons and become what are called nitrogen *ions*. Each one has only six electron planets instead of the seven it had before. In the same way the oxygen atoms lose one electron and become oxygen ions, each with seven planetary electrons instead of eight. That is ionization.

One of the most important results of ionization is that the air becomes a conductor for electricity. Each ion has a small charge of positive electricity. These charges act as carriers for the current. Air with many ions in it may have its

(*Continued on page 117*)

Why You Make Errors in Summer

By Donald A. Laird, Ph.D.

Associate Professor of Psychology, Colgate University

I WONDER if you realize how much effect the weather exerts on your daily life and activities?

How much less work do you think you can do on the hot days that are more or less seasonable now than you could on pleasant days last spring? To what extent do you think your ability to concentrate has been affected by the heat? How much less accurate do you think you are now than you were a few months ago?

Very little, you probably will say. But science knows better. Scientific tests of workers in diverse lines of endeavor show that on the hot and sultry days of summer your energy, and consequently your physical and mental efficiency, may be reduced by as much as 60 per cent! Moreover, when the thermometer registers 90 degrees or more, you are about twice as likely to make an error in work requiring concentration and accuracy as you are on days of moderate temperature!

THESE figures, of course, are extreme. But science has learned that variations in the weather cause surprising variations in human energy.

Large business concerns have recognized that their employees are affected by weather changes. When Dr. Edwin Grant Dexter, psychologist, who now is director of the National Institute of Panama, was investigating the effect of weather and climate on human efficiency some time ago, he was told by the head of a factory employing 3000 workers, that a disagreeable day yields about 10 per cent less work than a fine day.

I, myself, have received similar testimony from employers, and have noted the fact in the classroom.

Now, just why our ability to work and concentrate varies with the weather science has not determined exactly. The decrease in efficiency that comes with disagreeable weather probably is due in part to discomfort. Another tenable explanation, however, is that the lowered efficiency is due to changes in the metabolism, or chemical action of the body.

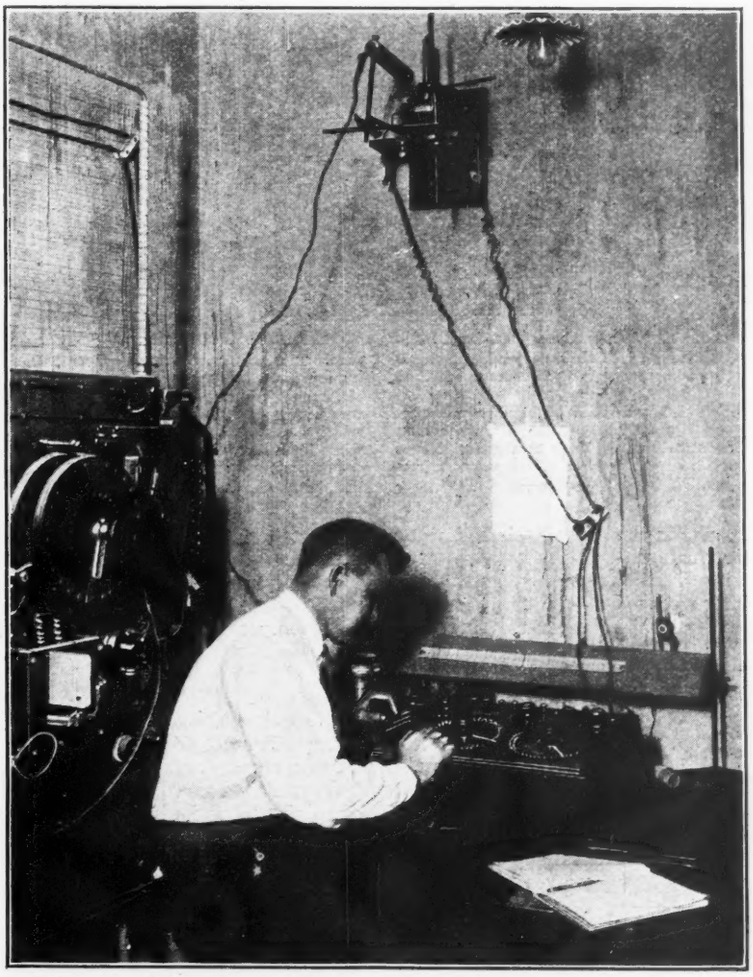
It is a law of chemistry that chemical activity is speeded up by heat and retarded by cold. And so it is quite reasonable to assume that varying meteorological conditions affect directly the chemical processes of the body.

At this time of year, for example, the chemical action of our bodies is increased to such an extent that waste products pile up more rapidly than we can absorb oxygen to destroy them. The effect of this accumulation of waste is the same as fatigue; hence, the inertia that prevails in the summertime; the reason why summertime is mistake-time. However, we cannot blame it all on the summer. Intense cold also causes a reduction in physical and mental energy. In this case, the chemical processes of the body probably are so slowed up by lack of heat that the energy produced falls below normal.

All of this means that it behooves you to make especial efforts to guard against errors in your work whenever it is especially hot or especially cold.

I am not basing this advice on an unproved theory. Whatever causes our supply of energy to hop up and down like the mercury in a thermometer, the fact remains that it does so, as shown by a very comprehensive test conducted by Doctor Dexter.

This test was entirely practical and the subjects did not realize that it was being made. They were the clerical forces of several banks in a large eastern city. They merely went about their daily work, and their efficiency was checked up by noting the errors they made. It was found that the number of errors was low in spring, that it increased markedly during the summer, dropped again during the fall, increased again during the winter, though not to the summer maximum, and then dropped in the spring.



Delicate electrical apparatus used by the United States Bureau of Mines in scientific tests to determine the effects of high temperatures on the health, comfort, and efficiency of the human body. Surface temperatures of a human subject under intense heat in an adjacent test chamber are recorded by means of the potentiometer, shown above, which is connected by wires with a thermocouple in contact with the subject's body. Among the effects of high temperature on the body, as shown by the tests, were exhaustion, restlessness, and irritability, headache, palpitation of the heart, inflammation of the eyes, dizziness, and mental confusion. Weakness and a "dragged out" feeling followed the test

A SIGNIFICANT coincidence regarding this seasonal occurrence of errors was that when the results of the investigation were plotted graphically, the curve of errors resembled remarkably the curve of the death rate. In other words, weather, health, and efficiency apparently bore definite relations to one another.

Dr. Ellsworth Huntington, of Yale University, has made an exhaustive study of the effect of weather and climate on human efficiency, with similar results. Doctor Huntington conducted his investigation among 2500 workers in Connecticut, North and South Carolina, Georgia and Florida, and among all the students of United States Military Academy at West Point and the United States Naval Academy at Annapolis.

He found that the mild months—April and October particularly—were most conducive to efficiency in both mental and physical effort. For most physical workers, temperatures averaging between 55 and 65 degrees were best; that is, times when the average daytime temperature was about 75 degrees, dropping to 45 degrees at night. Mental workers seemed to do better at lower temperatures—when the thermometer reached 55 degrees by day and dropped to freezing at night.

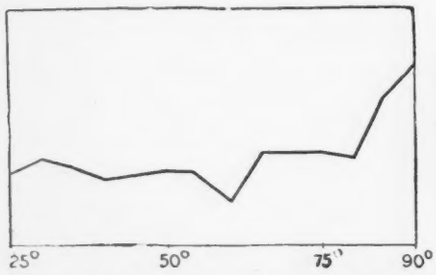
Neither class of workers did well either in excessively hot or excessively cold

weather. As soon as the average temperature dropped below 30 degrees or rose above 70 degrees, there was a definite falling off in efficiency—as much as 60 per cent when the thermometer reached 90 degrees or more.

The effect of temperature on efficiency varied, of course, according to location. Thus, workers in Florida, accustomed to relatively higher temperatures the year through than workers in New England, were able to withstand temperatures above 90 degrees without any such loss of efficiency as the Northerners showed for corresponding temperatures.

NOW, from this you might assume that you can acquire independence of the weather by seeking a uniformly mild climate and living and working there the year round.

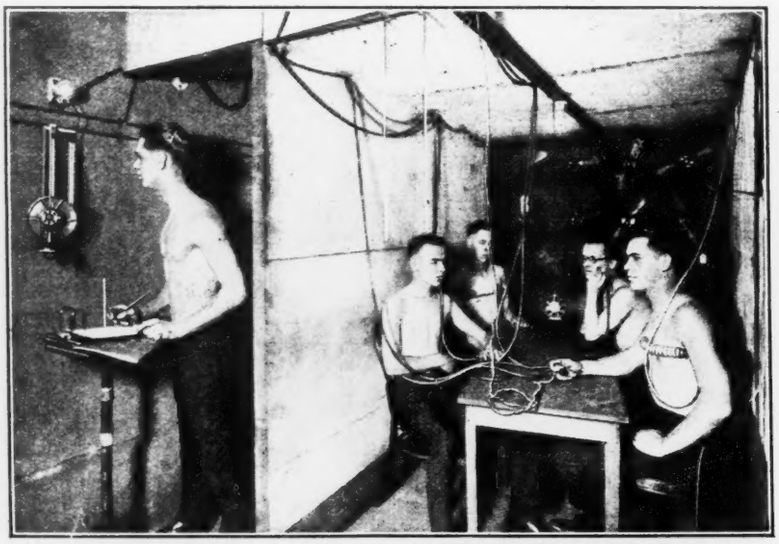
Doctor Huntington's test, however, shows that the weather problem is not so easily solved. Where there is little change in temperature from day to day, he found that the quality of work gradually declines. The human body requires change, and a change in the weather, whether for better or worse, invariably was found beneficial. Even a rainy day after a long spell of fair weather was a mental and physical spur. Similarly, either a rise or fall in temperature increased productiveness, except when the change was very great and very sudden.



The broken line indicates how the number of mistakes in bookkeeping varies with temperature. Notice that the point of greatest efficiency lies at about 60° F., and that the number of mistakes generally increases with the rise in temperature above that point

IT IS on this liking of your body for change that the beneficial effects of a summer vacation depend. Merely resting from your accustomed labors for a couple of weeks in the summer will benefit you, but the best vacation is one that includes a climatic change. The man from inland who visits the seashore and the man from the coast who goes to the mountains both subject their bodies to unaccustomed climatic influences, with the result that their physical processes are stimulated and they return to their homes refreshed and invigorated. Moreover, their return is itself a change after a period passed elsewhere and the benefits of the trip to the country are multiplied correspondingly.

One class of workers makes its own weather changes through virtually the whole year with most satisfactory results—salesmen and others who pass part of their time outdoors and part indoors. Usually they are conspicuous for their energy, and it is quite conceivable that this energy has its source in their frequent exposure to widely varying temperatures.



Interior view of the insulated test chambers where subjects of the Bureau of Mines experiments, stripped to the waist, undergo varying degrees of high temperature and humidity. Precision instruments accurately record their bodily reactions to the heat—their weight, temperature, respiration, heart pulsations, and blood pressure. The experiments disclosed that the human body, in a state of rest and in still air, cannot endure indefinitely a temperature higher than 90° F., with 100 per cent relative humidity. They showed also that while fat men lost more weight than lean ones when subjected to uncomfortably hot temperatures, they were less exhausted

A SCIENTIST of my acquaintance utilizes this stimulating effect of frequent weather changes. He keeps his laboratory or office at a temperature of 65 degrees or so, but, when doing any sort of intensive work, he goes frequently to an open window to work or think. Thus he reduces the external temperature of his body by a cool draft and consequently improves his working efficiency.

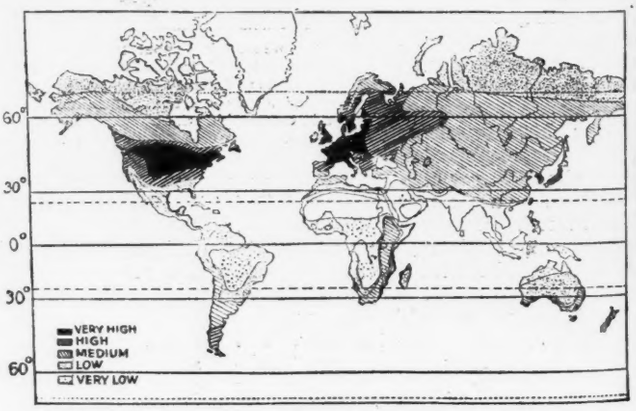
Besides temperature, humidity—the moisture in the atmosphere—has considerable effect on working efficiency. As a general thing, moisture in the air increases our supply of energy, perhaps by helping the chemical action of our bodies, perhaps by making us more comfortable. Excessively humid days, which are common at this time of year, however, lower the working efficiency, probably because they are very hot in addition to being very moist. The air in winter ordinarily is moist enough, and winter in consequence should make an admirable time for work. That it does not probably is due in great measure to the fact that most winter work is performed indoors, where artificial heating dries the air.

Stout persons generally are supposed to suffer more from hot weather than their slim neighbors. Possibly they do, in point of discomfort; yet the United States Bureau of Mines determined recently that some fat men actually stand the heat better than lean ones. Among a group of men tested for their physical reactions to extremely high temperatures, the heavier and stouter men lost more weight than the lighter and thinner ones; yet they were able to stand the high temperatures for a longer time and complained less of exhaustion when the test was finished.

IT IS difficult to be your own weather maker in the summertime. In winter you can stay indoors, go out, humidify the air and otherwise modify atmospheric conditions to some extent. In summer, though, outside of turning on the electric fan or taking a cooling shower bath, there is little you can do to reduce your body temperature.

Of course, the weather supplies a handy excuse any time we don't feel like working, but why not be honest with ourselves, and blame the weather only when the weather is at fault?

Guard your attitudes. Don't let them lower your efficiency. In other words, don't quit to the weather without a fight. If, on the days when you don't feel like working, you make a special effort to work particularly hard, it is altogether likely that so far as you are concerned summertime will cease to be mistake-time.

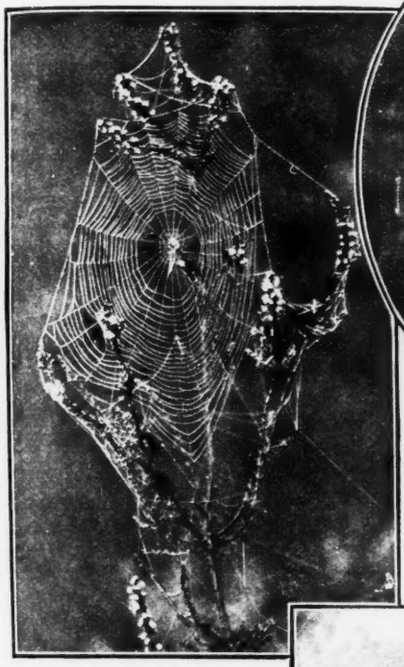


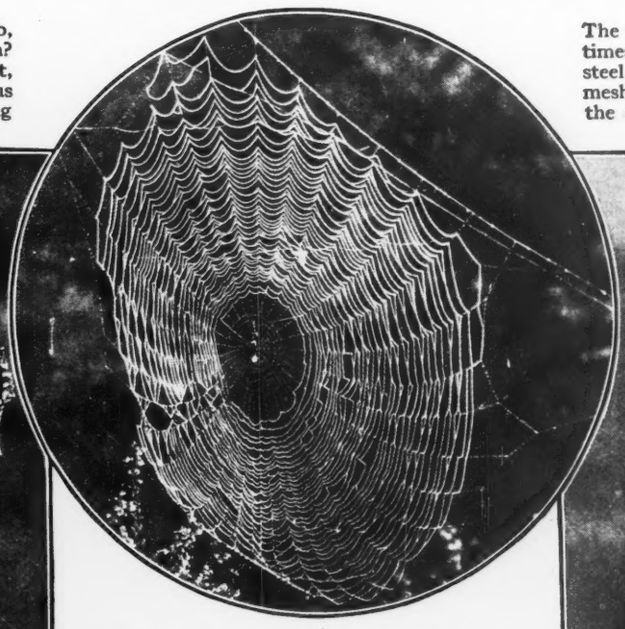
This shaded map of the world, reproduced from "Civilization and Climate," by Ellsworth Huntington, noted geographer, indicates a definite relation between temperature and human efficiency. Notice that the regions of highest efficiency—the United States and western Europe, indicated by the black and heavily shaded portions—fall mostly in the temperate zone, between 30° and 60° north latitude. The lowest efficiency, on the other hand, is found in the extreme heat of the equatorial regions or the extreme cold of the polar regions

Dewdrops Display the Spider's Art

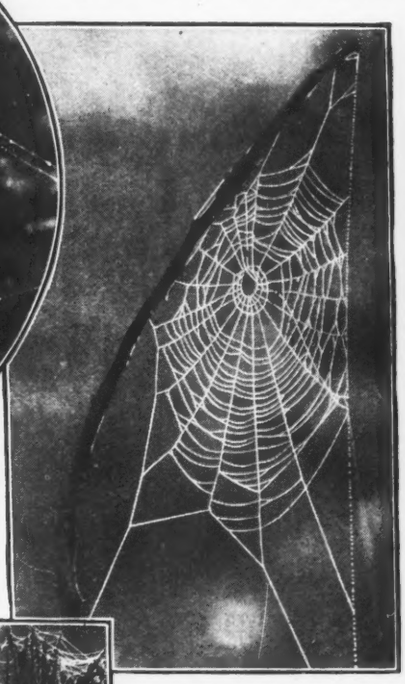
HAVE you seen a spider's web, glistening with dew in the dawn? Nature offers no more charming sight, for the dewdrops reveal the marvelous structure and beauty of the spinning

The threads of the web are of silk, 100 times finer than hair, yet stronger than steel, and consequently capable of enmeshing even large insects upon which the spider bandit satisfies its appetite

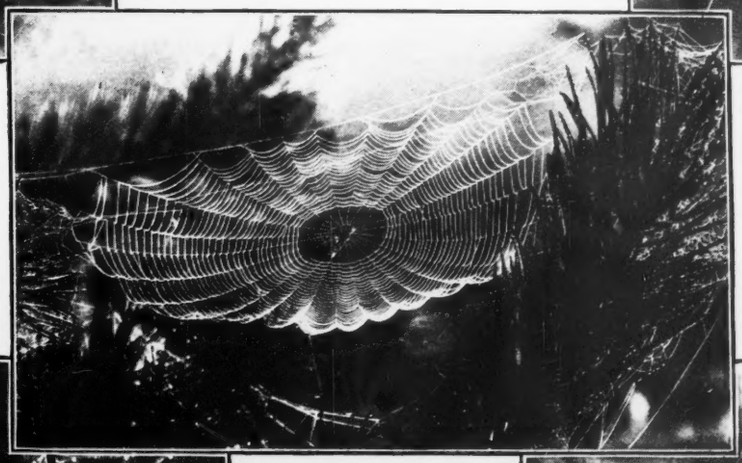




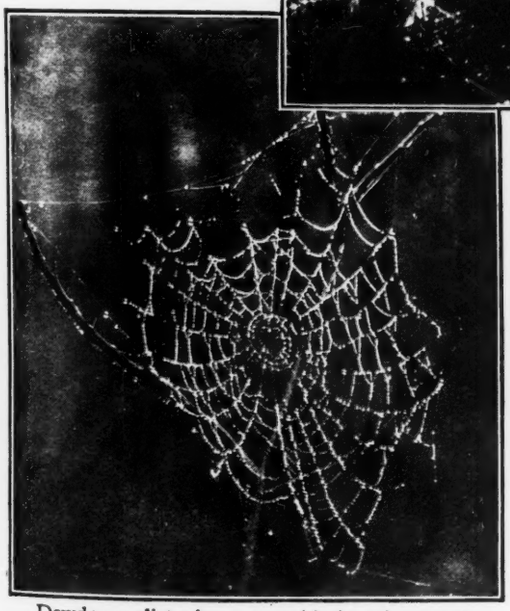
The compact, close weave of a web like this makes it easy to understand how the spider sometimes uses its silk for an airplane, floating with the wind at great heights



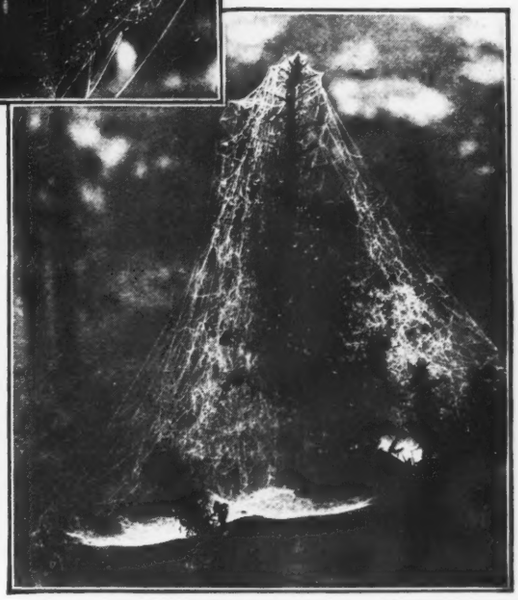
No two spider webs can be exactly alike, for their shape is determined by the location of the twigs to which the supporting threads are fastened. The web forms an efficient telegraph system. The spider learns that its prey is in the toils by vibrations caused by the captive's struggles



The threads that make up a delicate web like this issue from glands in the spider's body. The first thread spun is permitted to float in the air until it catches on some object. Then the spider creeps along it, fastens the other end, and begins construction of the intricate network



A half-hour suffices for the construction of even so complicated a web as this. The spider usually works at night. The outline is spun first; then the spider fills it in, installing the threads that radiate from the center, and last of all spinning the cross threads. These are wound in symmetrical pattern, crossing the others at angles of about 90 degrees. The spider makes doubly sure of capturing its prey by smearing the completed web with a glue-like, clinging substance



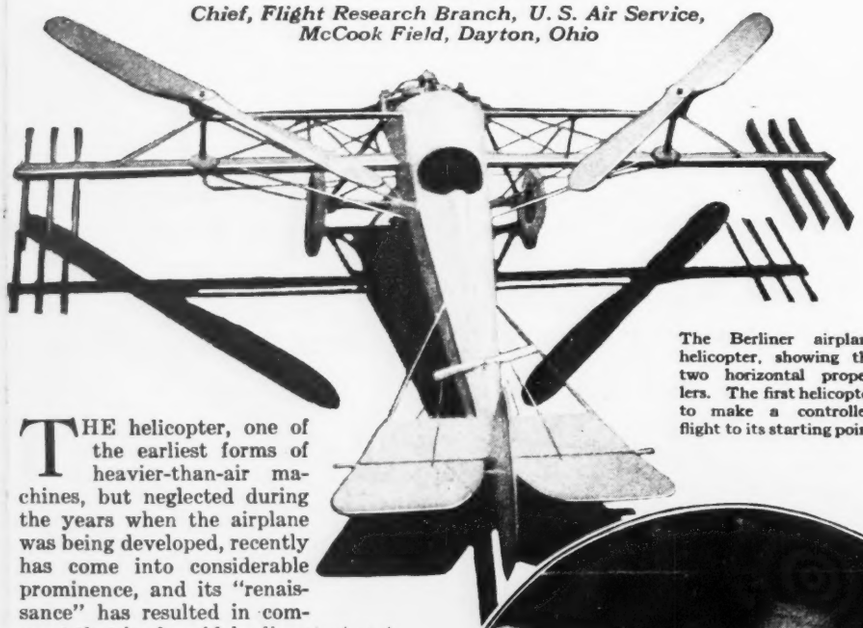
Dewdrops glistening on a spider's web at early morning resemble ropes of tiny pearls. The effect is beautiful, but annoying to the spider because the dewy festoons are plainly visible, making the web of very little use as a snare

Some members of the spider families weave their webs in tangled veils like this. It seems remarkable that the spider never becomes enmeshed in its complicated net. Its instinct, though, enables it to find its way about

Straight Up! The Dream of Fliers

By W. F. Gerhardt

Chief, Flight Research Branch, U. S. Air Service, McCook Field, Dayton, Ohio



The Berliner airplane helicopter, showing the two horizontal propellers. The first helicopter to make a controlled flight to its starting point

THE helicopter, one of the earliest forms of heavier-than-air machines, but neglected during the years when the airplane was being developed, recently has come into considerable prominence, and its "renaissance" has resulted in comment that is of a widely divergent sort.

Many of its exponents would have us believe that the future will see it displacing all other forms of aircraft, while its opponents are equally insistent that its possibilities are so limited as to be negligible. A favorite statement of those who see little in the helicopter is that it can do nothing that a balloon cannot do.

Of course, neither of these views can be entirely correct. It is obviously impossible to pass on the merits or demerits of a mechanical apparatus that has not yet reached its final form, and the helicopter today is far from perfection. In fact, the helicopter as we know it must be regarded merely as a step in a development. The machines of the future probably will be quite different from those we have seen. Certainly they will be simpler.

Now, just what is a helicopter? What is it supposed to do, and how does it accomplish its purpose?

Pescara's invention executing a well controlled vertical flight. This machine recently flew 187 feet in a straight line and completed a circular course approximately 130 feet in diameter

PROBABLY the name itself will shed a little light on the sort of machine it is. Helicopter is derived from two Greek words—*helix*, a spiral, and *pteron*, a wing. In other words, a helicopter is an aircraft with spiral wings, or at least wings that describe a spiral path in ascending or descending. This construction permits the machine to rise straight up in the air, instead of rising in a gradual incline like an airplane. In a helicopter the screw effect of a revolving propeller that drives an airplane forward is utilized to produce a vertical lift.

The mere ability to go straight up and down, however, will not make the helicopter a practical, useful aircraft. It must, in addition, do everything an airplane can do, which means that it must possess mobility, stability, control and the ability to effect a safe landing in case its motor fails.

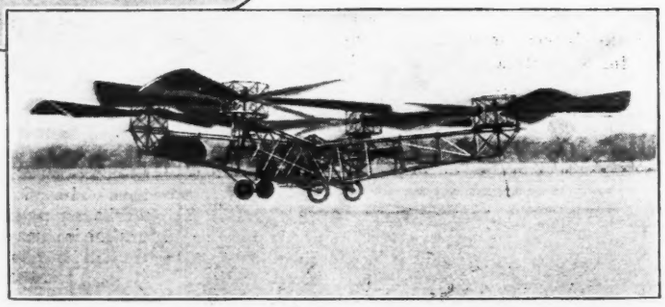
If it is to match an airplane in mobility, the helicopter must be able to climb from the ground to an altitude of several thousand feet. This it has not yet been able to do. The reason for this is that a tremendous force is necessary to lift any heavy object vertically, a fact well illustrated by the difference between trying to lift a barrel to a wagon and rolling it up on skids.

When a helicopter first starts to climb, it is aided by the air displaced by its revolving wings and reflected back against it from the ground. After it has ascended to a height equal to the diameter of its screws, however, this upward rush of air from the ground does not reach it. The machine then must depend entirely on its own power to overcome gravity, and no helicopter has proved capable of doing this for more than a comparatively few feet. Beyond the ability to climb, the helicopter must also have a horizontal speed at least equal to the cross-country speed of an automobile, or it offers no advantage as a means of transportation.

But the most difficult and probably the most important problem is that of providing the helicopter with a means of landing safely when the motor fails. A pure helicopter should be able to descend vertically and land safely; that is, drop to the earth with controlled speed that would gradually lessen and cause the machine to come to rest softly and slowly. To effect this the screws must be large—comparable in area with the wings of an airplane.

THERE are hybrid machines—airplane helicopters—that, when the motor fails, glide to earth like airplanes on auxiliary wings. Like airplanes, these machines have high ground speed in landing. Hence, they either must be traveling at that speed when the motor fails, or, if stationary, must be so high that they can glide to earth "out of a spin."

The best example of the airplane helicopter is the Berliner apparatus, the inventor of which—Emile Berliner—probably is the outstanding American experimenter in this field of aeronautics. This machine looks exactly like an airplane and has the same fundamental lifting and control elements. Instead of a single propeller in front, though, two horizontal propellers rotating in opposite directions are placed above the wings outboard, and are driven by a bevel gear and shaft from an engine in the nose of the fuselage.



The DeBothezat helicopter, built for the U. S. government. It has succeeded in remaining stationary in the air 35 feet above ground for five minutes, and has ascended four feet with two passengers and 17 feet with one

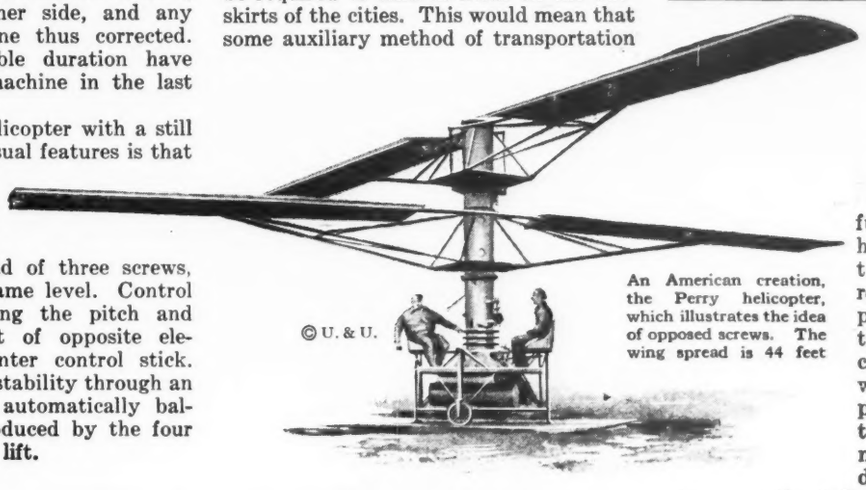
A SMALL propeller with adjustable pitch, driven by the same motor and located at the rear of the fuselage, supplies forward motion. Lateral balance and control are provided by vanes placed under the propellers. These vary the thrust of the two propellers in whatever direction it is necessary to tilt the plane. An early model of this machine

was the first vertical lifting craft to make a controlled flight back to its starting point.

THERE are many examples of the pure helicopter. One of the first successful machines of this type was that of Professor Von Karman, of Austria. At the top of this machine are two propellers rotating on a common axis but in opposite directions, which balance each other and prevent the machine from rotating. The propellers are driven by three rotary motors located in a tripod-shaped fuselage. A recent model of this machine made some noteworthy altitude flights. In the cockpit is a parachute that opens if the motor fails, and causes the machine to drop slowly enough to assure safety for the pilot.

Mr. Pescara, an Argentine engineer working in France, recently developed a machine that in many ways is similar to that of Professor Von Karman. This also has two screws rotating in opposite directions and driven from below, but there is only one motor. The inventor, moreover, has added a noticeable improvement in a method of controlling the propelling screw. The pitch of the blades is varied throughout the rotation by means of a set of cams controlled from the pilot's seat. By this method the thrust distribution can be shifted forward, backward, or to either side, and any tilting of the machine thus corrected. Flights of considerable duration have been made in this machine in the last few months.

Another type of helicopter with a still larger number of unusual features is that developed by Doctor DeBothezat for the United States Government. This machine has four instead of three screws, and all are on the same level. Control is effected by varying the pitch and consequently the lift of opposite elements through a center control stick. The machine obtains stability through an ingenious system of automatically balancing the forces produced by the four screws for a vertical lift.



An American creation, the Perry helicopter, which illustrates the idea of opposed screws. The wing spread is 44 feet

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Von Karman's helicopter taking off. This is an early model without the cockpit shown in the upper picture. The propellers are driven by three rotary motors in the tripod-shaped fuselage

M. Oehmichen, whose experiments in Paris have attracted wide attention, has a device similar to the DeBothezat machine. It differs, though, in the stability system that depends on the gyrostatic action of a flywheel on the motor and the shape of the screws, which have narrow tips and wide hubs.

A successful helicopter cannot be more complicated in its operating mechanism than an airplane. That is to say, a pilot must be required to use no more than two hand movements and one foot movement to obtain all possible movements of his craft. The machine must be designed, too, so that if the power plant fails, the mechanism will not be left unbalanced.

These obviously are difficult conditions to meet. However, somewhat similar problems confronted the pioneers in the development of the airplane, and were solved successfully, so aviation engineers expect confidently that a practicable helicopter eventually will be produced.

IT REQUIRES no special technical knowledge to predict what status the helicopter will occupy in the aviation of the future. The helicopter will be used only where the flight is one principally of ascent and descent in a vertical plane; where taking off and landing are the main operations of the trip, and where only a small machine can maneuver with safety and convenience.

Let us suppose, for example, that an airplane line were established between two big cities such as New York and Chicago. Huge airplanes, capable of carrying a large number of passengers, would be the logical units of transportation. By their nature these machines would be required to land in fields on the outskirts of the cities. This would mean that some auxiliary method of transportation would be necessary to carry passengers to the cities themselves. Automobiles would offer the most convenient method of doing this, but helicopters probably would be even better—assuming, of course, that the helicopter had reached a stage of development that made it just as safe and just as fast as the automobile. For the helicopter would be independent of the delays caused by heavy traffic, and it could transport passengers directly to their hotels or offices, landing on the roofs of the buildings.

Another important and perhaps a wider use will be for personal transportation. In my opinion, there is a definite future for the "flivver" helicopter. No matter to what point of refinement "flivver" planes are developed, there always will be crowded districts in which it will be impossible for them to take off or land. The most congested city district would offer no terrors to the helicopter, provided there was a roof convenient for use as a landing platform.

Held captive by cables, Von Karman's helicopter established a record by ascending 150 feet with two men aboard. An unusual feature is the position of the cockpit above the two horizontal lifting propellers

THAT the helicopter ever will displace the airplane, though, is unthinkable. Airplanes and dirigibles are absolutely beyond competition where aircraft capable of long flights at high speed are required for such purposes as the transportation of passengers, freight, and mails between cities. To lift itself vertically the helicopter has to pay in power expended for the purpose and in mechanical complexities, both of which detract from its likelihood of becoming a craft capable of prolonged, fast flight.

At present the experimenter in helicopters finds his encouragement not in the possibility of immediate use of his invention, but in the opportunity to enter the competitions that are contemplated in various countries. Great Britain, France, and Italy already have arranged competitions, and the British event, which is to be held before next spring, offers attractive inducements in prize money.

In the Vanguard of Science

Keep in Step with Useful New Discoveries and Inventions

FOR years the telegraph has apprised us of the news of the world almost as the events have occurred. Now it also can show us pictures of far-off happenings with a speed little less than that required to transmit an account of them, for engineers of the American Telephone and Telegraph Company have perfected a simple, commercially practical method of sending photographs by wire.

The process was put to a thorough test during the recent Democratic and Republican conventions at New York and Cleveland respectively. Only two instruments capable of exchanging photographs by the new system are in existence, but the success with which the convention pictures were transmitted probably will lead to the construction of others, and sending pictures by wire eventually may become common practice. Both receiving and sending apparatus are adaptable to radio.

Physicists of the U. S. Bureau of Standards are shown above melting thorium oxide, the substance used in making crucibles for holding molten metal, and that has resisted hitherto all attempts to melt it because of the terrific heat required for the purpose

THE new process has for its basis a photo-electric cell, an apparatus the electrical conductivity of which varies according to the amount of light entering the cell. A positive film of the picture to be transmitted is placed on a revolving cylinder and a thin ray of light directed against it. This ray moves vertically across the film in lines that are 1/65 of an inch apart.

As the ray passes through the film, its intensity constantly varies according to the lights and shadows of the picture, causing corresponding variance in the current that issues from a photo-electric cell. This current is transmitted along a wire to the receiving station, where the received current is transformed into variations in a light ray. The ray is directed against a photographic film, moving across it as the ray moved on the sending film.

Since the two films are of the same size, and the movements and intensities of both sending and receiving ray coincide, the film on the sending cylinder is reproduced exactly at the other end. Vacuum tubes and other auxiliary apparatus are required for long-distance transmission, but the foregoing will serve to explain the essential features of the process.

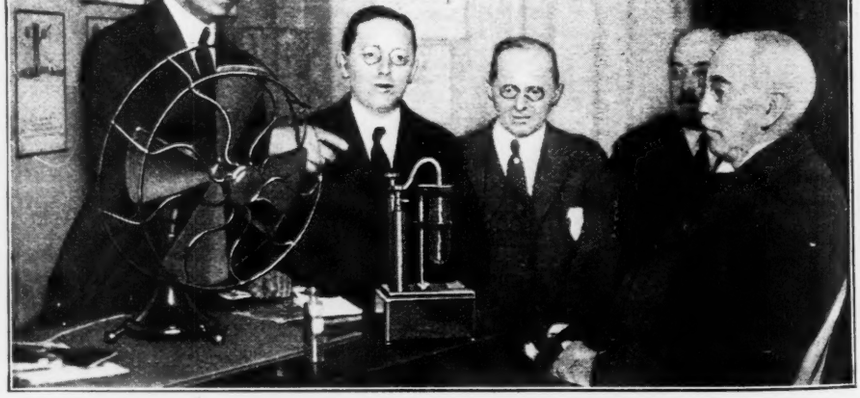
It requires about 4½ minutes to transmit a five by seven photograph by means of a ray that moves 65 times in an inch. This gives to the received picture about the same quality as a newspaper halftone. By causing the light ray to describe more than 65 lines to the inch, the original photograph may be transmitted more perfectly, though, of course, it would require longer.

Artificial Breath

TWO scientists appeared before the French Academy of Medicine a few weeks ago and placed on a long table the bodies of several animals. Some of the animals had been poisoned by carbon monoxide; others had been subjected to other deadly gases; the respiratory centers of others had been paralyzed. All gave every external evidence of being dead and yet a few minutes later all of the animals were hopping about, apparently in normal health and none the worse for their experience.

This seeming miracle was accomplished by means of a new apparatus designed to resuscitate victims of drowning or asphyxiation. It consists of two bellows, operated by an electric motor, one of which "exhales," the other of which "inhales" in a way that is said to imitate perfectly the action of the lungs.

The artificial breath from the bellows is transmitted to the sufferer either by a tube placed in the throat or through a mask that covers the face. This method is said to be more certain than any previous system of artificial respiration.



Chlorine gas, used as a weapon of death in war, recently has come into use as an effective remedy for the treatment of colds. The view above shows officials of the New York City Department of Health witnessing a demonstration of the new and effective treatment which will be described in detail in next month's issue of Popular Science Monthly

A King of Locomotives

AS A result of four years' work and at a cost of more than $100,000, engineers of the American Locomotive Company and the Delaware and Hudson Railroad have produced what is said to be the most powerful steam locomotive.

The new engine operates at 350 pounds steam pressure, while the average freight locomotive utilizes from 175 to 220 pounds. It has two small wheels forward, and four driving wheels, lacking the usual trailer wheels. This change in design is said to produce greater tractional force. Its smoke box is small, and the boiler is virtually hidden under a mass of heavy steam pipes.

A novel feature of the compound engine of the new locomotive is that steam is utilized twice before exhaust. It is passed at high pressure into one cylinder, then led into a larger cylinder on the other side at slightly reduced pressure, then exhausted through the stack.

The development of so powerful a steam locomotive is significant in these days when electrical and internal-combustion locomotives are attracting wide attention. It is remarkable also that the new locomotive utilizes an engine of the compound type, once discarded by locomotive designers as "inefficient."

Receiving a photograph. This apparatus is part of the new system for transmitting pictures by telephone, described on the opposite page

In an attempt to explain the mysterious "zones of silence" noted during the war and to determine whether there really are blank areas skipped by sound waves as they radiate, French army engineers recently set off a terrific explosion at La Courtine, France. The picture at the left shows the actual blast in which the experimenters used 10 tons of melinite, one of the most powerful explosives in the world. To determine the effect of the explosion on living bodies, dogs were tethered near the scene, as shown above. Paris, 275 miles away, neither heard nor felt the blast

Photographing the Invisible

LIEUTENANTS MACREADY and Stevens of the Army Air Service ascended in an airplane 32,220 feet above Dayton, Ohio, a few weeks ago. At that height their airplane was invisible from the ground. When they looked down, the city was obscured by a blue haze that rose from 8000 to 10,000 feet from the ground. Yet they snapped their camera several times, and obtained remarkable photographs of the city—pictures in which the buildings, even the automobiles in the streets, were defined clearly.

That they were able to make pictures of objects invisible to them was due to three factors—an extra long-focus camera, super-speed film, and a "minus blue" ray filter that absorbed the ground haze. No aerial photograph ever before had been made from such a height as six miles, yet photographic experts of the Air Service say that the limit has not been reached. With a camera having a focal length of 20 inches, they say, clear photographs of the objects below are possible from a height of 48,000 feet—if airmen ever succeed in rising that high.

An Aid to Super-Power

FROM England recently came word of the invention of a device that is expected to revolutionize the transmission of electric power—a "transverter," a combination transformer and converter, that changes ordinary low-pressure alternating current into high-pressure direct current.

The new apparatus is the invention of W. E. Highfield and J. E. Calverey, engineers of the English Electric Company, who had been engaged in its development since 1918. Engineering experts in the United States have shown tremendous interest in the device, stating that it probably will further the super-power projects of this country by facilitating the interconnection of various power lines and power houses.

Engineers long have dreamed of substituting high-voltage direct current in transmission lines for high-voltage alternating current, but to make the change was impossible, due to the lack of a device that would convert the alternating current developed by the generators into direct current. The new device makes the transformation; then, after transmission, a similar device steps the high-voltage direct current down to low-voltage alternating current for industrial purposes.

Around the World in 17 Days

PEOPLE were vastly entertained when Jules Verne had his fictional hero, *Phineas Fogg*, make a circuit of the globe in 80 days, an exploit quite as fanciful as other feats that Verne had his characters perform. A commercial concern announces round-the-world trips by airship and airplane *in 17 days* and causes no astonishment! A $5,000,000 company has been formed in London to conduct these tours according to the following itinerary: London to Paris to Constantinople by airplane; to Australia by airship; to San Francisco by airship; to New York by airplane; to London by airship.

Bricks Made from Dirt

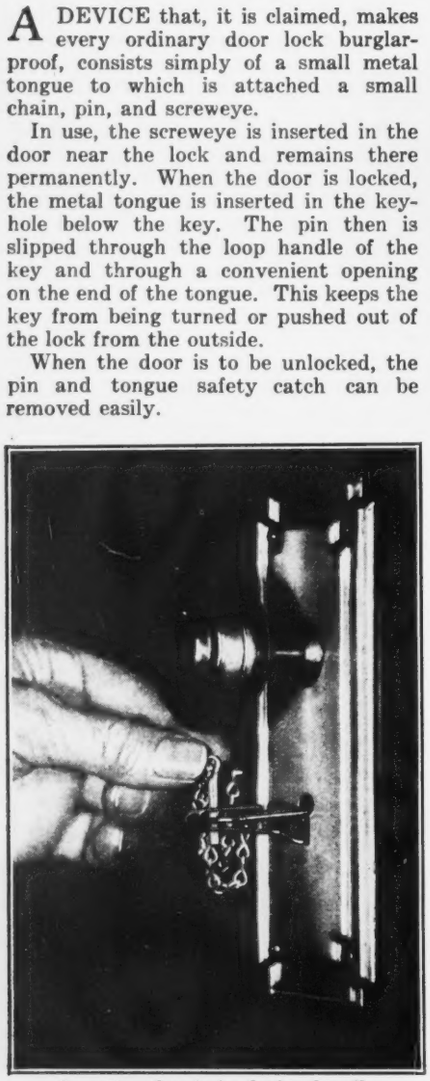
COMPRESSED bricks made from ordinary dirt have been developed for house construction by two French engineers. In the process ordinary subsoil earth containing five to eight per cent clay is compressed by tremendous pressure. The resultant bricks are said to have a pressure resistance of 600 pounds a square inch.

Double-Locking the Door against Burglars

A DEVICE that, it is claimed, makes every ordinary door lock burglar-proof, consists simply of a small metal tongue to which is attached a small chain, pin, and screweye.

In use, the screweye is inserted in the door near the lock and remains there permanently. When the door is locked, the metal tongue is inserted in the key-hole below the key. The pin then is slipped through the loop handle of the key and through a convenient opening on the end of the tongue. This keeps the key from being turned or pushed out of the lock from the outside.

When the door is to be unlocked, the pin and tongue safety catch can be removed easily.



Inserting the pin in the key handle

Above: The movable steel channel stalls.
Right: How the skyscraper garage will appear

Skyscraper Garage Will Park 600 Cars

TO RELIEVE congested parking conditions, a skyscraper garage, the first of its kind, is being planned for Chicago, Ill. It is designed to park between 600 and 700 automobiles and to carry the cars, without the aid of attendants, from the ground to the upper floors.

The building is to be a 40-story structure, including a tower. Part of 23 stories will be given over to garage space. Congestion will be eliminated by having entrances and exits at different levels.

Entering, the car will be driven on to a platform, the engine stopped, and the owner given a check. Compressed air will raise the rear of the platform 18 inches, rolling the car on to an automatic electric elevator, which then carries the car to a floor above for storage.

When the car reaches the floor designated by an attendant below, the elevator stops, the gates automatically open, the rear of the elevator floor is raised and the car is rolled into its stall by force of gravity. The stall consists of steel channels for the wheels and will be movable, so that when a car is run out from the elevator it may be slid away from the entrance, making room for the next car.

The designers claim that hotels and department stores of the future may have their own garages incorporated in the buildings.

Telephone Arm Holds Receiver to Your Ear

A PRACTICAL telephone device consists of a holder for the receiver when in use, allowing freedom of both hands while telephoning, and a handy pad holder supplied with a clip so that papers of various sizes may be used.

A Wasp that Uses Tools

THE definition of man as a tool-using animal may have to be revised. Dr. George C. Wheeler and Esther Hall Wheeler, of Syracuse University, recently reported having seen a wasp using a pebble for tamping down the entrance to her burrow.

The incident happened in Texas, where the observers were studying insect life. Arrested by a loud buzzing, they caught sight of the wasp at work. The insect was holding the pebble between her mandibles and striking it against the ground by moving her whole body up and down after the fashion of a pile-driver.

The scientists captured the wasp, but the pebble was lost in the excitement.

Steel Pipe Foundations Filled with Concrete

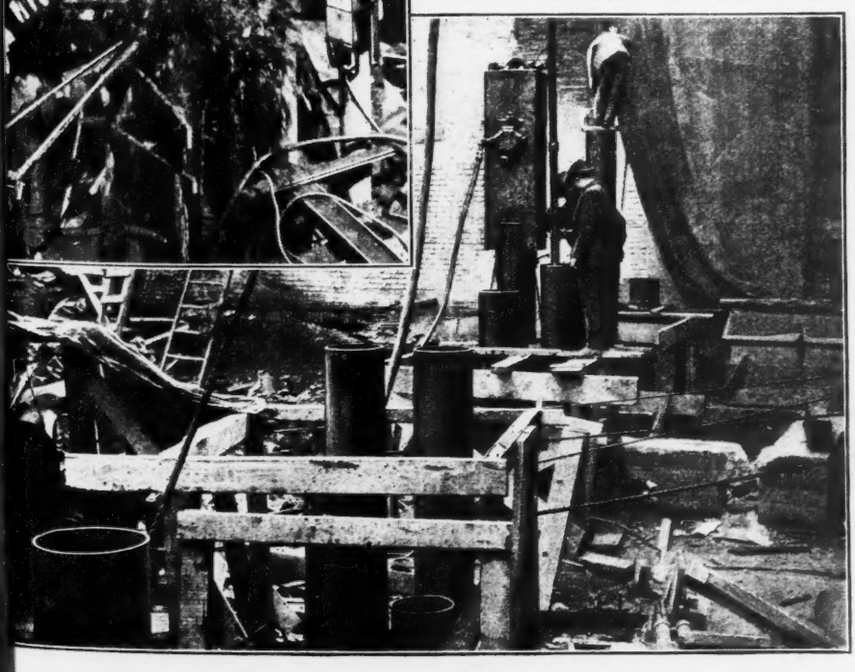
FOUNDATIONS of steel tubing filled with concrete that, it is claimed, may be laid at a saving of time and cost over the usual concrete piers employed in building operations, have been devised by a firm of New York engineers.

By the new method, tubular steel shells from 12¾ to 16 inches in diameter and from ⅜ to ½ inch in thickness are driven down to bed rock. The length and thickness of the shells depend on the load to be carried and the earth through which they must be driven. Cast steel couplings provide rigid connections when more than one length of tubing is used.

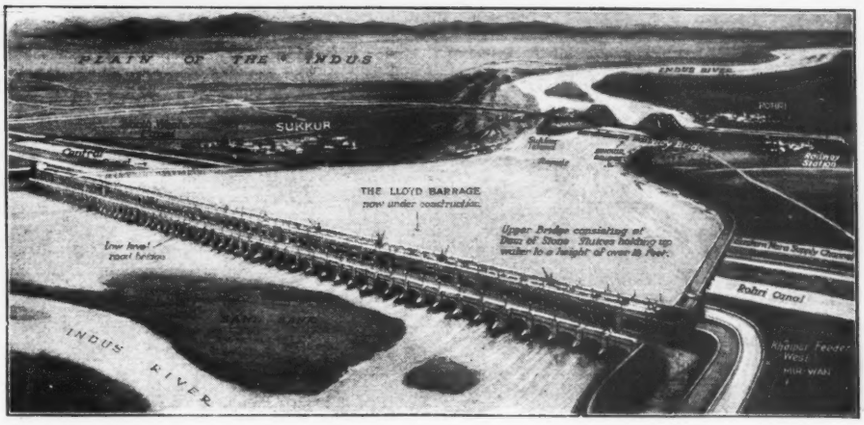
Since there is little displacement of material as the shell is forced into the ground, previous excavating is unnecessary. The material inside the shell is excavated by a powerful jet of compressed air from a small auxiliary pipe, which is inserted after the tube has been driven.

When the earth is extremely hard, water is added to loosen the core and to make the tube airtight, so that the blowing by compressed air will be more effective. After this, clear water is run in to clean the pipe. Finally the pipe is filled with concrete, forming a reinforced concrete column.

The concrete steel piles are set in groups and bound together at the top by a reinforced concrete cap.



The tubular steel shells are sunk to bed rock, as shown below. Then the material within the shell is blown out by compressed air, as at the left, and replaced by concrete



The World's Greatest Irrigation Project

WORK on the greatest irrigation project in history, the plan of which is shown above, was begun recently by British engineers. It provides for regulating the flow of waters of the Indus River in India, to irrigate by seven great canals and tributaries the arid plains of Sind, including 6,000,000 acres of land now largely desert.

To accomplish this, a great dam will be constructed across the Indus in the form of a double bridge more than a mile long, or five times the length of London Bridge.

The upper bridge will be used for handling the gear operating the giant sluices, of which there will be 66, each closed by huge steel gates. The lower bridge will carry a public roadway. Building material will be of limestone from neighboring hills.

The largest of the canals is designed to irrigate more than 2,000,000 acres. Altogether there will be 850 miles of main canal with branches, and more than 1200 miles of distributaries.

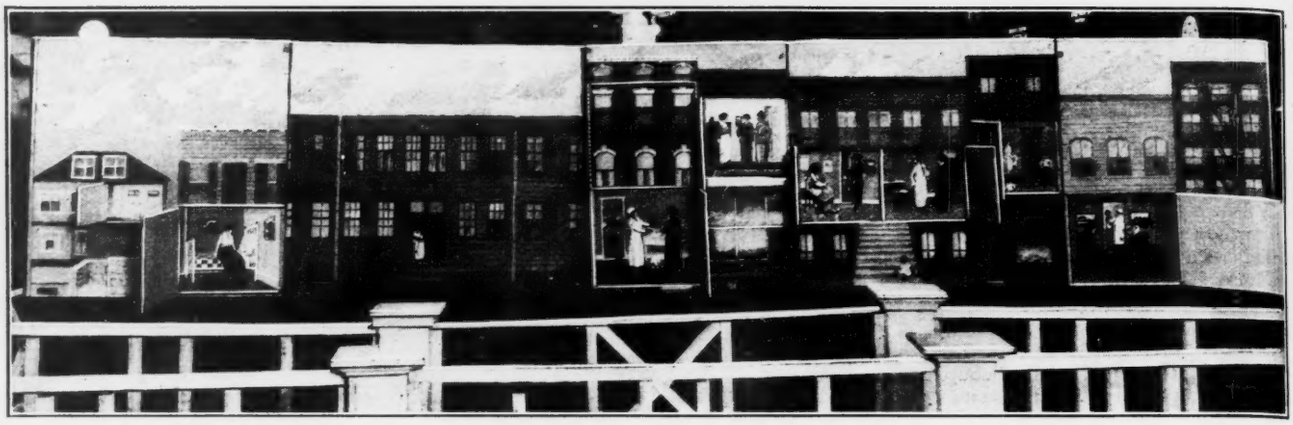
The central canal will be half as wide again as the Suez Canal and its discharge will approach the maximum discharge of the Thames. The cost of the dam will be more than $14,000,000, and the entire project will cost more than $50,000,000. The scheme was originated by Sir George Lloyd, Governor of Bombay from 1918 to 1923.

An Automatic Policeman

ABSOLUTE protection for the automobile and everything in it now is promised by a "metal policeman" that sounds the horn as a warning signal as long as the car is molested.

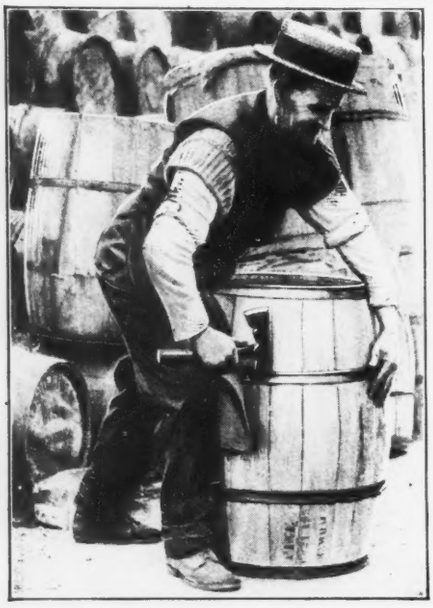
The burglar device, designed also to protect garages, barns, and similar buildings, is an electric alarm with a secret switch. It consists of a series of electric contacts arranged in a metal box four inches square and one inch thick. When attached to a car it may be secreted under the hood. When the owner leaves the car he sets the secret alarm switch. Thereafter the slightest jar causes a spring to vibrate and make a contact. A small wheel with a series of notches on it is set into motion. Each of these notches makes a contact as it passes a copper spring, sounding the horn. The result is a series of short startling toots of the horn, which continue for 10 seconds.

If the thief continues to molest the car, the process is repeated indefinitely.



Model "Health Street" Demonstrates Child Hygiene Work

TO DEMONSTRATE the importance of child hygiene education in the home, the Department of Health, Newark, N. J., recently prepared a model street for a public health exhibition. All of the buildings were fitted with swinging fronts which, when opened, presented an interior of the rooms in each building, revealing the various types of educational health work carried on in the home by the bureau. This method of visualizing the work aroused considerable interest.



Champion Barrel Builder Makes 120 a Day

IN THESE days of dancing, whistling, and fiddling champions, there now appears William J. Murphy, of Massachusetts, who claims to be the champion barrel maker in the United States.

He holds a record of making 120 barrels a day for 44 days straight, a total of 5280 barrels in all.

Murphy, who is employed by a South Boston cooper, challenges all comers to dispute his title.

Flappers in the South Seas

THE bobbed-haired miss with henna-hued curls is not an exclusively modern product. On the Samoan Islands, native men wear their hair long. The women, however, cut theirs short and bleach it an auburn tint with a wash that is compounded from the leaves of a wild plant.

Beauty spots made from alafa, a thin leaflike fungus, often are stuck on their foreheads and cheeks. These patches, which are phosphorescent, give the belles a striking appearance at night.

New Fighting Tank Can Be Directed by Radio

EVEN the army fighting tank now has radio ears and a radio voice. This doughty perambulating fort now can be directed accurately from behind the lines throughout a battle, a fact that the designers believe would increase its destructive power enormously in time of war.

Because of the deafening noise within a tank during fighting, a special design had to be developed. The tank shown at the right on the proving ground at Aberdeen, Md., was the first to be equipped with radio.

A CAMERA that takes 250 pictures a second recently was developed by the U. S. Bureau of Standards to study the flight of projectiles from big guns.

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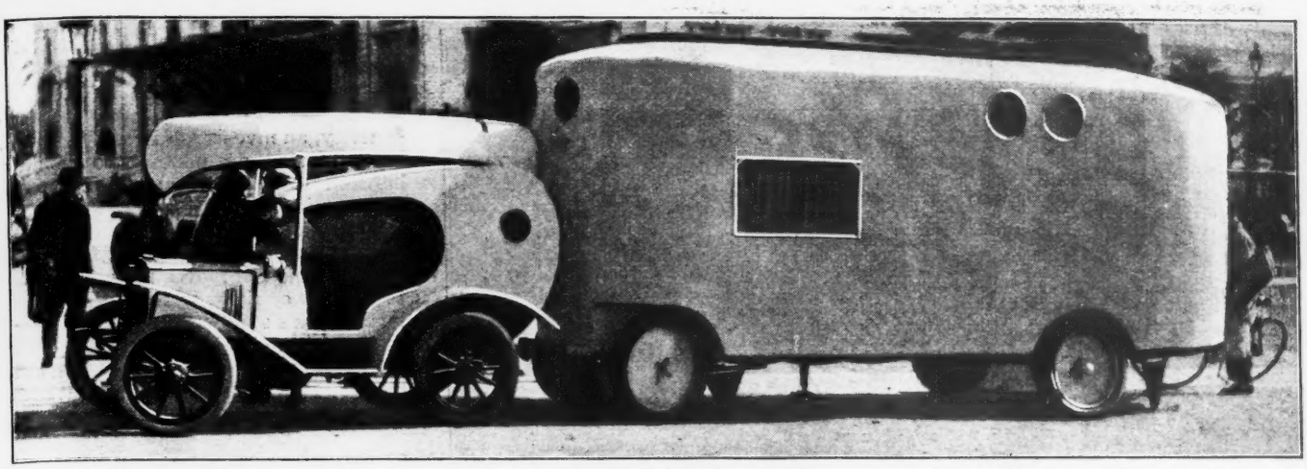
New army tank equipped with radio

"Strong Woman" Lifts Elephant for Charity

TO ASSIST a New York charity fair, a "strong woman" vaudeville performer stopped the crowds at Times Square recently by lifting an elephant. The animal stood on a specially constructed platform, suspended by chains from straps slung over the performer's shoulders.

Bracing herself on a platform with feet wide spread, her hands gripping a horizontal bar on each side, the woman lifted the tremendous load.

Street crowds watching woman performer lift an elephant hung from her shoulders



Odd Motor Caravan on the Riviera Carries Its Own Canoe

THE latest style for a sight-seeing trip on the Riviera is by motor caravan. Vacationists at Cannes, France, recently were startled by the sight of a diminutive car not much longer than the canoe it carried on its odd top, drawing a very large hooded trailer that served as a covered home on wheels. In appearance the trailer resembled a great armored car.

The strange caravan, canoe and all, is shown above just as it appeared in Cannes.

A snug garage in a hollow tree

Great Hollow Tree Trunk a Natural Garage

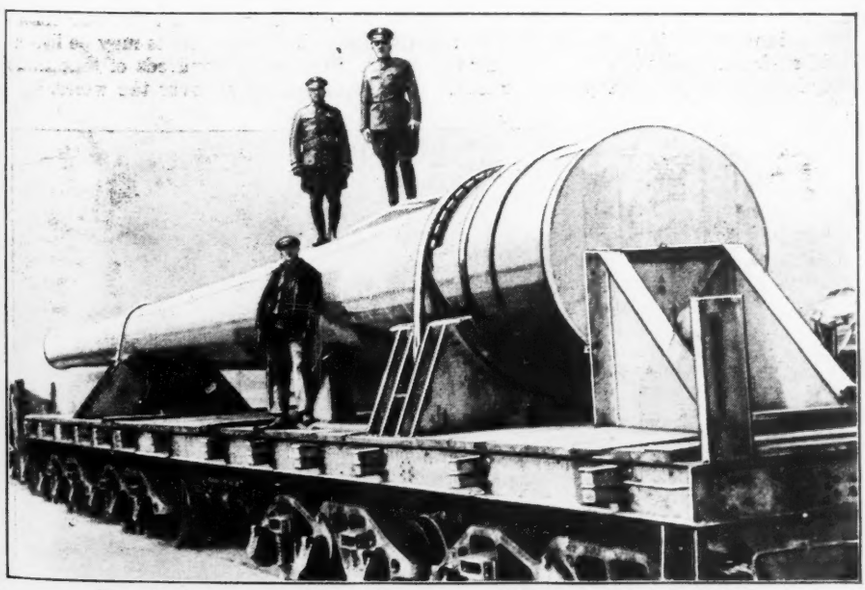
A HUGE natural garage in the hollow of a great baobab tree, was discovered recently by a motorist in Nyassaland, Africa, shortly before nightfall. His car, a Ford, was accommodated handily by the high sheltered space. Despite its great hollow, the tree was alive.

Earth's Permanent Wave

WITHIN the earth is a large wave that moves around the planet once every 8800 years, according to Ludovic MacLellan Mann, a member of the British Royal Anthropological Society. He says the wave moves the position of the earth's axis and poles slightly, resulting in climatic changes.

Shipping a Mammoth Coast Defense Gun

ONE of the world's largest coast defense guns, recently shipped to New England, is shown below. The 16-inch weapon weighs 210 tons. A specially constructed car was necessary for transportation and 50 men to move it.



How the huge gun, weighing 210 tons, was shipped on a special flat car

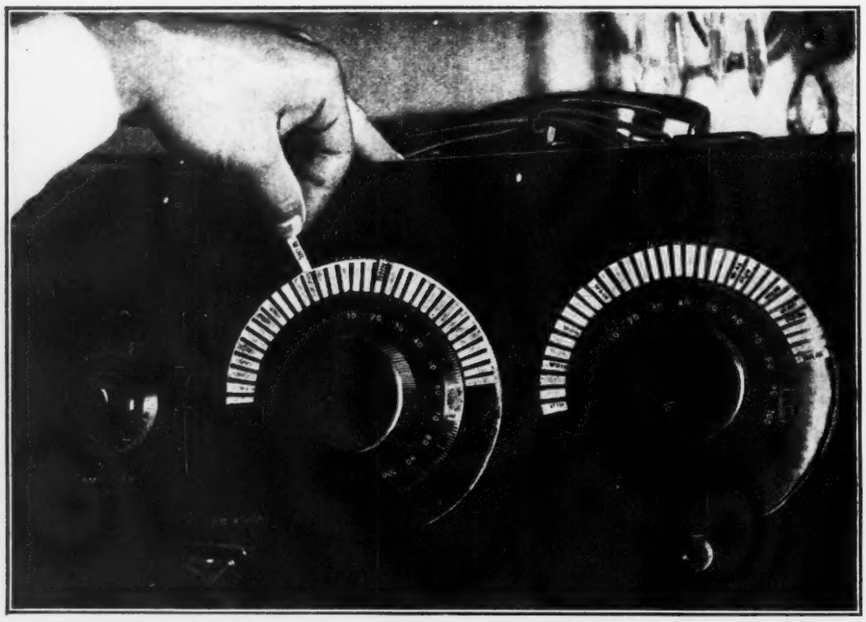
The world's largest lamp, above, compared with the smallest, at right

Smallest and Largest Lamps

THE world's smallest and largest incandescent lamps—one rated at about one quarter candlepower and the other at 100,000 candlepower—recently were exhibited by the General Electric Company.

The large lamp, with a bulb 12 inches in diameter and 18½ inches high, was developed for motion-picture studios. It is 1290 times larger than the average household lamp. The current required to operate three of these lamps would run the average street car.

The small lamp, only a quarter of an inch in diameter, uses but one-fifth of a volt of electricity.



Simple Card Index Aids in Quick Tuning

SLOTTED cardboard disks inserted behind the tuning dials of your set so that a portion of each disk is exposed to view, can be made to serve as a handy index for quickly tuning in any desired station, without the usual adjustments over a wide range.

On small pieces of cardboard that fit into the disk slots are printed the call letters of the various broadcasting station within range. When a station is tuned in first, the card bearing its call letter is inserted in a slot opposite the zero mark on the dial, as shown at the left of the illustration above.

Thereafter, whenever you desire to tune in the same station, all that is necessary is to turn the dial until the zero mark is opposite the call letters on the card index.

Two-Way Loop Aerial for Greater Selectivity

IN AN attempt to obtain perfect selectivity, an inventor of Brooklyn, N. Y., has perfected an unusual combination horizontal-vertical loop aerial to be used with sensitive receiving sets.

Tuning of the aerial is accomplished by turning the dial shown in the photograph below. This dial moves the vertical loop to the left or right, while the horizontal loop remains stationary.

The inventor claims that despite strong interference from local stations, the combination loop will bring in distant stations at the slightest turn of the dial.

Tuning the horizontal-vertical aerial

Liquid Resistance Used in New Grid Leak

A NEW type of grid leak differing from other types in the fact that it uses a liquid for its high resistance element, recently has been developed to eliminate microphonic noises.

The new instrument is composed of a glass tube one-half inch in diameter and five-eighths of an inch long, about one-third full of liquid. At each end, on the inside of the glass tube, is a small semi-circular copper plate.

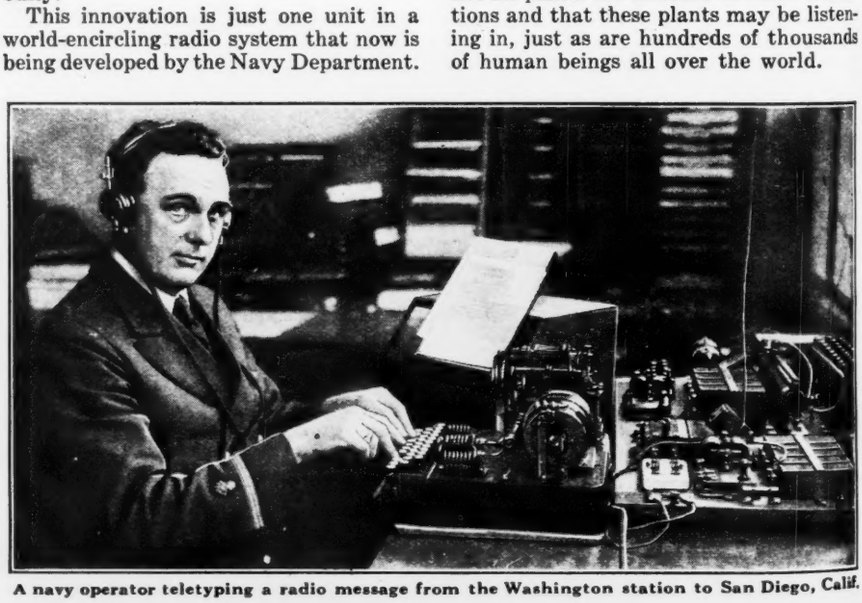
As the grid leak is revolved in its mounting, the plates are gradually immersed in the fluid. In immersion, the grid leak has the minimum resistance of one-quarter megohm. When it is turned so that the plates are completely out of the fluid, it has the maximum resistance of two megohms.

Thus the device can be adjusted for any resistance between these two points merely by turning it on its mounting.

U. S. Navy's Radio Messages Sent by Typewriter

IN THE U. S. Navy's "radio central" station at Washington, D. C., has been perfected a teletype system by which an operator, simply by "typing" messages on a lettered keyboard, can transmit navy communications by radio from Washington to San Diego, Calif. Depressing a key automatically transmits a dot-and-dash signal for that letter. Thus a navy operator, using headphones, as shown in the photograph below, can relay an incoming radio message almost instantaneously.

This innovation is just one unit in a world-encircling radio system that now is being developed by the Navy Department.



A navy operator teletyping a radio message from the Washington station to San Diego, Calif.

Plants Listening In

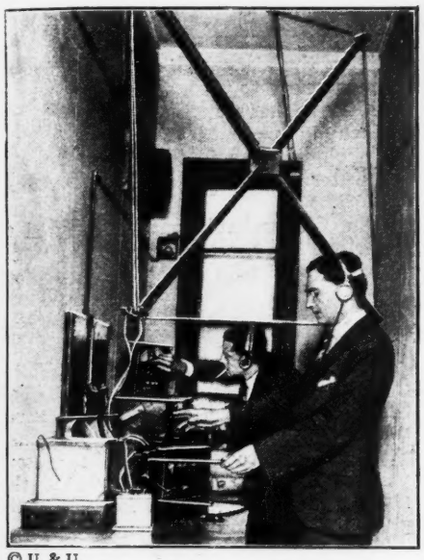
WILL plant life ultimately be affected by the ever increasing radio activity and the constant disturbance of the ether?

This question recently has been put to scientists of the Smithsonian Institution and the U. S. Department of Agriculture. While they are not ready to offer a definite prediction, they point out that some, if not all plants are sensible to ether conditions and that these plants may be listening in, just as are hundreds of thousands of human beings all over the world.

Thirteen-Tube Set Relays American Broadcasts

CERTAIN American stations are heard with crystal sets throughout the British Isles, the programs being received and amplified by this new 13-tube set, at Biggin Hill, Kent, England. Programs on a 100-meter wave length, too low for most American amateurs, are caught by this station and relayed from nine broadcasting stations, each with a different wave length. The programs thus relayed have been heard as far west as Australia and as far east as Russia.

A similar system for relaying British concerts is being developed for the United States.

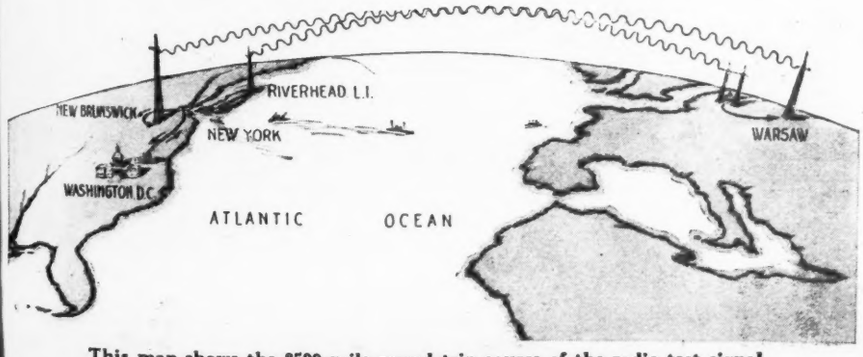


© U. & U.
Interior of British relay station

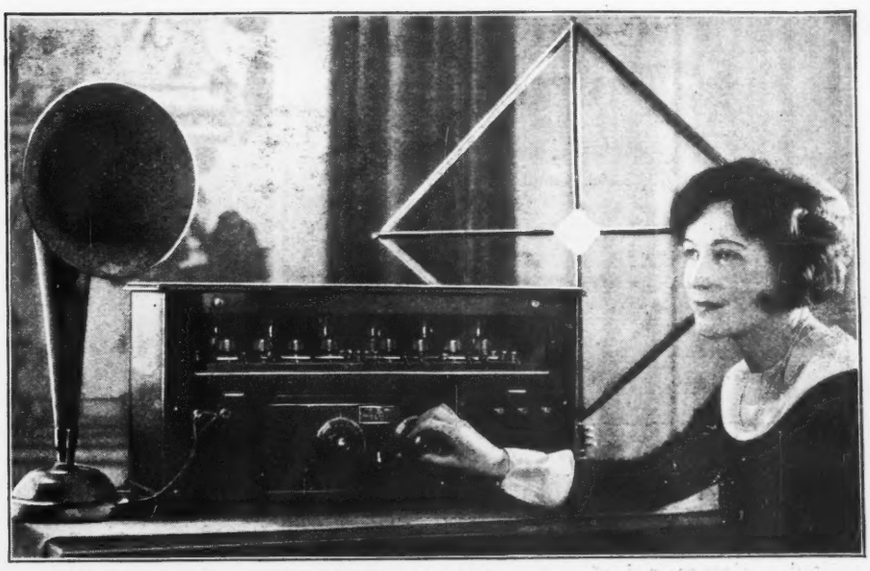
Signal Travels 8500 Miles in a Split Second

THE map below illustrates how, in 5/100 of a second, a radio signal recently streaked around an 8500-mile circuit; from New Brunswick, N. J., to Warsaw, Poland, and back to New York.

The round trip of the test signal was timed by a motion-picture camera actuated by a set tuned to the receiving station at Riverhead, L. I. This camera was in Washington, D. C., at a club where the observers were gathered. From this club the signal first was telegraphed to the sending station at New Brunswick, N. J. Thence it went to Warsaw, and from there, after a 35-mile telegraphic relay, was sent to the Riverhead station.



This map shows the 8500-mile round-trip course of the radio test signal



Tubes Are Visible in Powerful New Set

DIFFERING from the standard types of radio cabinets, this new six-tube set has a glass door at the top, through which the tubes are visible. This door may be opened to allow easy access to the rheostats placed between the tubes within. Two tuning dials are on the panel below.

The inventors of this type of set also have perfected a new folding loop aerial, which they claim is wound in such a manner that the wires cannot be tangled or bunched. It is equipped with taps so that 10, eight, or four turns can be used, giving a range of wave lengths from 180 to 600 meters.

This loop is said to be constructed as firmly as those that do not fold.

Operates Six Head Phones from a Single Set

WHERE several persons wish to listen in with separate headphones instead of a loudspeaker, some means must be provided to connect the various phones in series. This manner of connecting cuts down the volume on each phone.

When only one or two persons wish to listen, therefore, it is advisable to take from the circuit the phones not in use, thereby increasing the signal strength in the phones in use.

This has been accomplished in a very efficient manner by a radio manufacturer who has constructed a multiphone block in which a slider moving along a rod connects or disconnects from the circuit as many phones as are required. By using this device six persons can listen in.

A CAMPAIGN to curb the howls and squeals from radiating radio receivers was launched at a recent meeting of the Interfering Radiation Conference, when it was decided to join forces with the American Radio Association in educational work through the large broadcasting stations.

Multiple block for phone connections

Ammeter Battery Tests

TESTING radio A batteries with an ammeter is not a satisfactory method of determining the best brand, according to George W. Vinal, chief of the battery section of the United States Bureau of Standards.

Mr. Vinal explains that some of the very best and longest lived batteries do not give as high an ammeter indication in this test as inferior brands.

Mysterious Fire in Paved Roadway Has Been Burning a Year

FOURTEEN years after a creek bed in Philadelphia, Pa., had been converted into a paved street, a passing autoist noticed a slender curl of smoke rising from a slight crevice in the roadway, thus discovering a fire that probably will shatter all records for novelty and length of activity before it is finally subdued.

This discovery was made last summer. The motorist turned in an alarm, a fire company responded, and has been on duty ever since, establishing what is very likely an endurance record for fire fighting. They will soon complete their first year on the job.

When the road was laid in 1909, from 300 to 400 feet of the foundation was filled with cinders, coke, and other furnace refuse, and the highway laid over all. Fourteen years afterward the pavement was discovered to be a mass of fire. The cause is believed to have been spontaneous combustion. It is thought that several red hot coals from the fill-in material that, in many cases, was dumped direct from power houses, became sealed in the great mass of waste. This bit of fire slowly smoldered and spread until it permeated the entire foundation, finally gaining the air, which fanned the pavement furnace to fresh activity.

Firemen have succeeded in digging a trench in part of the burning mass through which a firehose creates a wall of water night and day, month after month.

The fire probably will be allowed to burn itself out, which, according to estimates, will take about three or four years more.

Gage Measures Clearance for Balloon Tires

A SIMPLE wooden gage has been devised to determine whether your car has sufficient clearance for use of balloon tires. The gage consists simply of a stick with holes at certain distances from one end. These distances correspond to what may be termed the radius of the clearance circle.

A nail is placed in the hole corresponding to the size of tire the car requires and the point of the nail held to the center of the hub. If the end of the gage in swinging around the nail as on an axis strikes the fender above, the clearance is inadequate.

All the above measurements are made with a maximum load in the car.

New Anti-Aircraft Gas

A GERMAN is reported to have invented an aerial defense gas that makes it impossible for any one breathing it to ascend higher than 6000 feet.

Beyond that height the aviator's lungs will burst.

Escalators for Salmon

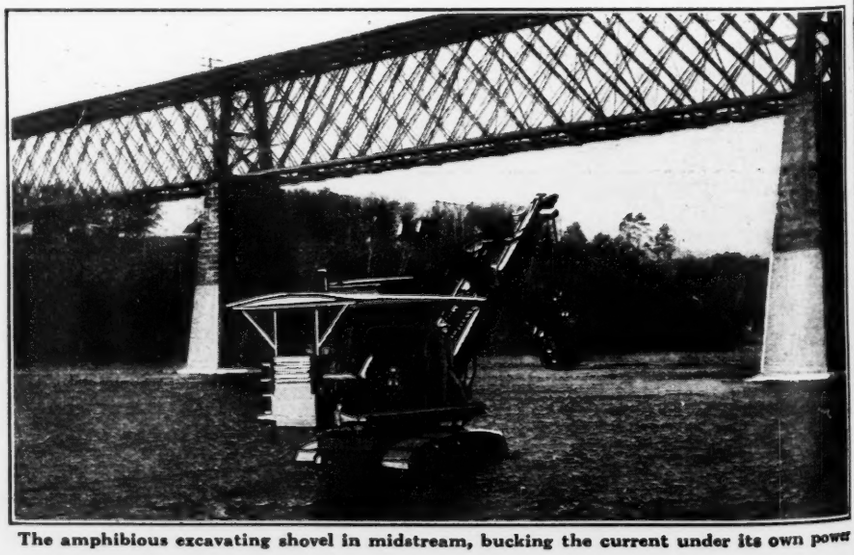
TO SOLVE the problem of building a 90-foot dam in the Columbia River without blocking the run of salmon that go up the river to spawn, model escalators will be erected to determine whether the fishes will consent to this form of transportation.

Excavating Shovel Swims to Work in River

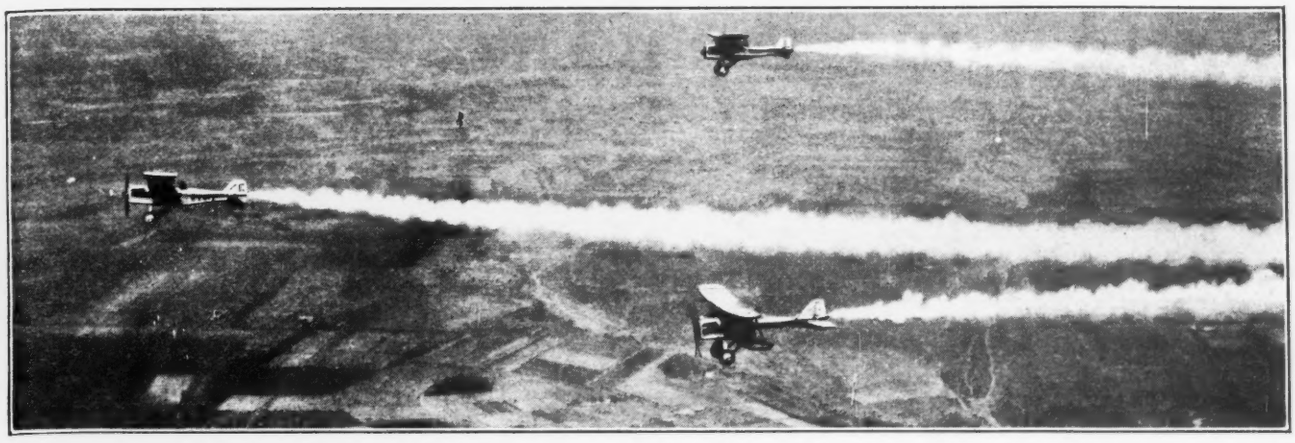
INSTEAD of dismantling a 22-ton excavating shovel in order to lower it from cliffs down to a dam at Eau Claire, Wis., engineers saved a week of time and expense by running the machine into the Chippewa River about a quarter of a mile below the dam and then moving it upstream under its own power.

It had been planned originally to disassemble the machine and skid the parts out on a platform, from which they could be lowered by derricks to the river 70 feet below and then reassembled. To save time, however, it was decided to make the shovel swim to work, so the engineers put three men aboard and started it on its unusual and treacherous trip, in which it encountered deep holes, hidden ledges, and swift currents.

At times the water almost reached the vital engine parts, but after 5½ hours' battling against the current, the shovel finally arrived at its destination and crawled out of the water like a huge hippopotamus, to the great satisfaction of the men who conceived the idea.



The amphibious excavating shovel in midstream, bucking the current under its own power



Airplanes Paint the Sky with Writing of Many Colors

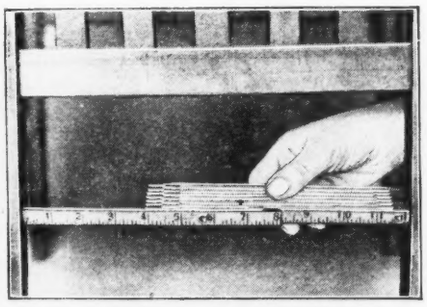
THE three planes shown above are painting the sky with colored writing over Hazelhurst Field, L. I. Traveling at a speed of 135 miles an hour, a camera man in another plane snapped this unusual picture.

The new method of painting the heavens with all the colors of the rainbow is the invention of Major Jack Savage.

Collapsible Rule Takes Inside Measurements

A COLLAPSIBLE rule designed to take inside measurements accurately consists of eight-inch sections, on the edges of which are grooves and runners that permit it to be pulled out for a short distance or to its full length of three feet.

A spring catch holds each section when it is pulled out to the full.



The collapsible rule partly pulled out

Mosquitoes Favor Cattle

IT LONG has been known that the mosquito is the only active carrier of malaria. Only one mosquito in 1000, though, carries the malaria parasite in an infectious stage, scientists of the Johns Hopkins School of Hygiene discovered in a recent investigation in Louisiana. They report also that mosquitoes show a much greater fondness for live stock than men.

It will be difficult to convince any one of that at this time of year, yet the investigators assert mosquitoes evidenced their preference in the following order: Horses, cows, dogs, pigs, human beings.

New Tip for Cutting Torch Saves Time and Fuel

ESPECIALLY designed for cutting heavy metals, a new tip for acetylene torches, recently developed, is said to effect a substantial saving of time and fuel by a new process of mixing the gases, preheating the cutting oxygen, and giving added velocity and penetration to the preheating and cutting jets.

This mixing of preheated gases takes place in several passages in the seat of the tip. The gases then pass into a ringlike passage, where they are given a swirling motion and an additional mixing. They are separated again, and expanded into larger passages which lead to the openings in the end of the tip itself.

The tip has the advantage of a renewable seat that facilitates cleaning and maintenance and does away with the necessity of discarding or remachining used tips with worn seats.

Results from tests, according to the manufacturer, showed a saving of 18 per cent.

Lake Steamers Carry Big Auto Shipments

THE Great Lakes rapidly are becoming major highways for transportation of automobiles. Manufacturers are beginning to load large freight steamships with hundreds of cars at Detroit for shipment to distributing points along the lakes instead of driving them overland or shipping them by rail.

Some of the large freighters carry more than 300 cars at one load. The photograph below shows a load of automobiles from Detroit at the Municipal Pier, Chicago.

Part of a boatload of 300 cars on a lake steamer from Detroit at Chicago

ARSENIC has been found in appreciable quantities in all organs of the human body, increasing in amount with the age of the person examined.

Could You Save a Drowning Man?

By Clifford Thorne, *Veteran Life-Guard*

MOST of us, some time in our lives, may expect to hear the terrified call for help from a drowning person; yet how many of us would know how to attempt a rescue?

Every day in the United States about 20 people meet death by drowning, so the value of general knowledge of life-saving is obvious. Few of us, however, take the trouble to learn.

Nearly 300 rescues have taught me that cool-headedness and a few simple, well-directed actions, rather than brute strength, are the chief requisites for life-saving. Most drownings are due to fear and excitement.

I recall once, just at dusk, I heard a call for help, saw a crowd of excited people on the beach and a man struggling in the water. No one was going to his aid. I saw that the victim was not suffering from cramps and was keeping his head above water. So I shouted at the crowd for silence, drew the attention of the victim, who was merely excited, and commanded him to swim in at once or I would order him off the beach for making a disturbance. He immediately regained his self confidence and swam to shore unaided.

Fig. 1. An effective way to carry a swimmer in distress. The rescuer swims face up

Fig. 2. How to break a wrist hold. Press your knee against the drowning person's arm

Fig. 3. To break a body hold from the rear, lift your arms shoulder high and duck out

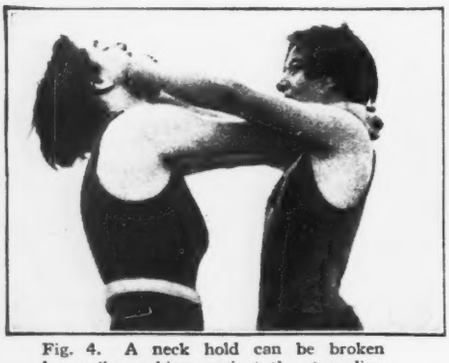


Fig. 4. A neck hold can be broken by easily pushing against the struggling victim's chin or nose with your hands

Fig. 5. The most effective way to tow a drowning person to safety—a hold that allows freedom enough for swimming

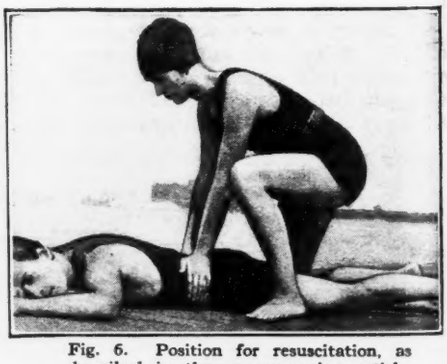


Fig. 6. Position for resuscitation, as described in the accompanying article. Turn the victim's face toward the air

If, however, you are forced to go into the water after a person, a few simple rules are worth knowing. First, forget about the so-called "death clutch." Actually, it is nothing more than a frantic effort of the drowning person to climb to the surface by using the rescuer as a ladder. If the rescuer will remain still a moment, the victim very likely will release or at least loosen his hold. If necessary, one of several releases and grips may be used.

IF THE victim should grasp you from behind, wrapping both arms around your waist, as in Figure 3, simply stiffen your arms and raise them to the height of your shoulders, then duck out quickly. To break a wrist hold, use your knee, as in Figure 2, pressing it against the victim's forearm. This will break the strongest grip. Figure 4 shows how to break a neck hold by pushing back the other person's chin with both hands.

The best way to tow a drowning person to safety is to throw one arm over his shoulder, across his chest and under the opposite armpit, as shown in Figure 5. Then swim on your back and pull him along. This hold will keep his head above water.

If the drowning person is wearing clothes, the most effective method is to grasp him from the rear. If the person will help a little, after being quieted by conversation, an excellent way to assist him in is to place one hand under each arm as in Figure 1, or on each side of the head, both of you swimming on your backs.

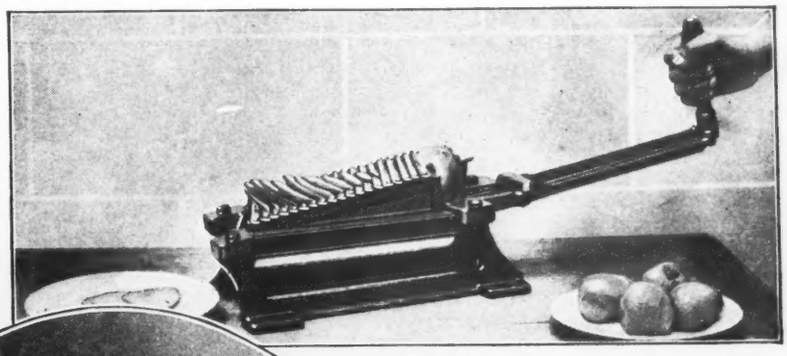
IT MAY surprise you to learn that stout persons are not more difficult to rescue than lightweights. In fact, stout persons float more readily. Another surprising fact is that clothing actually aids you, because of the air it retains for many minutes.

The first steps in resuscitation are to place the victim on his stomach, making sure to turn his face toward a current of air. Then clean his mouth and nose. Now grasp him firmly at the belt line, as in Figure 6, and, holding your arms stiff, sway backward, then forward and downward, exerting pressure on the abdomen. Release the pressure quickly on the backward movement for the purpose of getting the lungs to work again. This should be done slowly, about 15 times to the minute. If you have an assistant, have him hold the victim's tongue.

Remember always to act quickly and calmly.

New Inventions for the Housewife

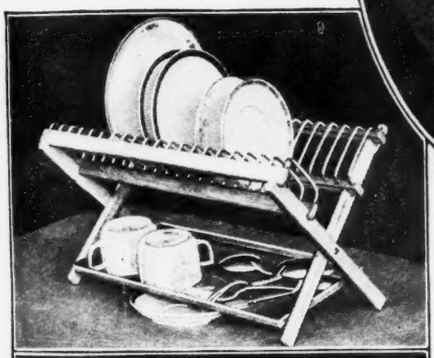
A padded spring above the wooden support of a dress hanger grips the garment firmly and holds it in shape

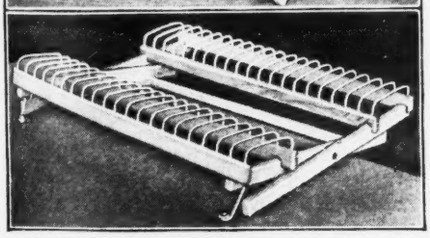


Fruit or vegetables are sliced quickly simply by inserting them in this device. Pushing the handle forces them through a series of sharp, parallel knife blades

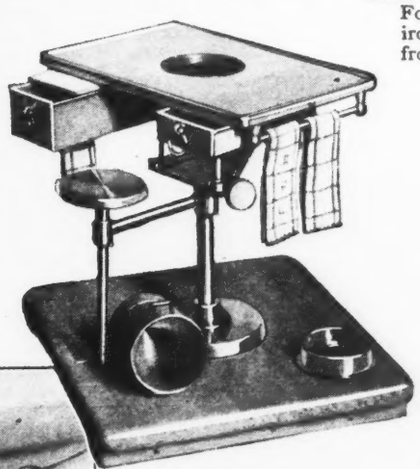
This novel kettle, with detachable spout, is easy to keep clean. The spout is also equipped with a strainer

Four electrical attachments—fan, radio, iron, and light—can be used at once from one outlet by means of a new plug

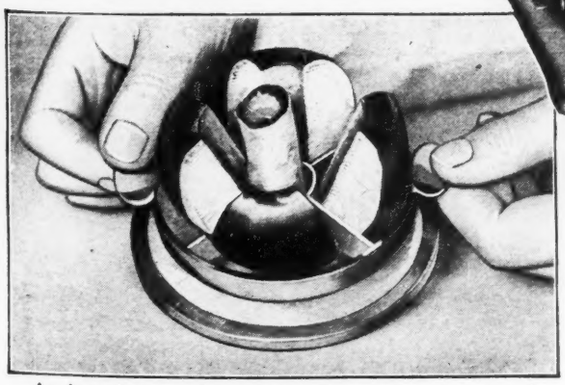




This compact dish-drying stand folds as shown below. When opened, wire racks hold the dishes, while a pan beneath holds the silver and the smaller articles

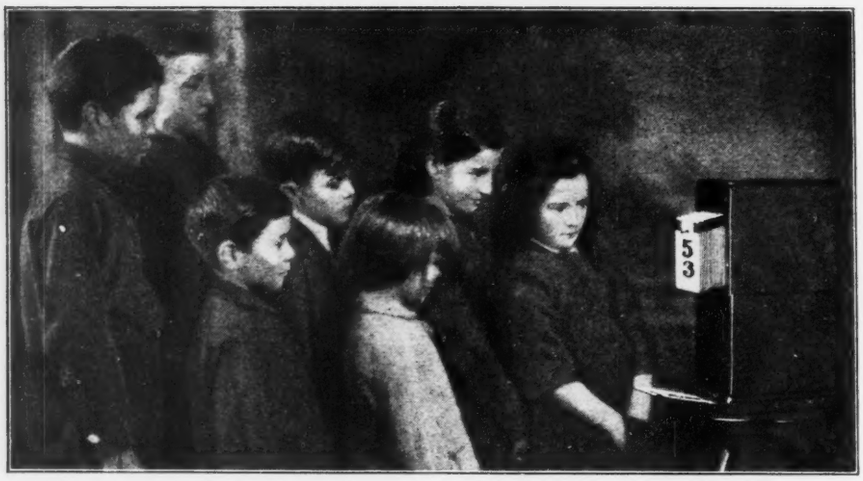


This sanitary kitchen table combines drawers for utensils, a sliding bread-board, a towel rack, an adjustable seat, and a refuse pail



An ingenious apple cutter and corer is so arranged that it not only cuts the core out cleanly, but slices the apple in quarters at the same time. Simply hold the apple against the knives of the device and press

An entire meal may be cooked on one burner, it is claimed, by using these four square pots of aluminum that fit together over the flame. The inventor claims their use will result in a 75 per cent saving of gas



Automatic Teacher Drills Young Scholars

AN AUTOMATIC teaching device, designed to aid children to master fundamental facts and to train them in automatic thought processes such as addition and combinations of numbers, has been developed especially for use in the lower school grades.

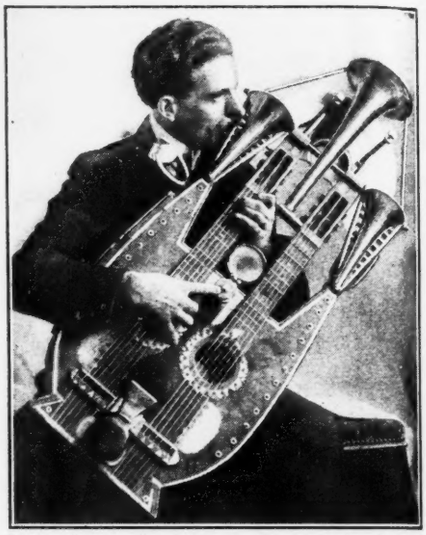
The device consists of a machine holding a set of about 50 cards on which the drill facts are printed, a set of cards covering one subject and forming one unit. The cards are placed on the machine, which automatically drops them in regular order at intervals of from one to three seconds. The child or class calls the answer to each card while it is exposed to view. Thus for drill in addition, each card bears a combination of numbers to which the scholars must quickly give the correct answer.

The card teaching machine is designed also for use in Americanization evening schools. Subjects covered include language, civics, history, and arithmetic.

Fourteen Instruments in One-Man Orchestra

COMBINING 14 different instruments in one, a novel one-man guitar, when properly played, is said to produce the effect of a real jazz band. The instruments are played at the same time in order to give the effect of a full orchestra.

The "band" was invented by Signor Miguel Juan, of Belgrade, Servia. He plans to bring his unique instrument to America soon.



How the combination instrument is played

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Fifty Years of Carving on Elephant Tusk

A MARVEL of patience and skill is represented in this beautifully carved elephant tusk on which a father and son worked nearly 50 years.

The carving was done by Hindus. When the father who started the work died, the son carried it to completion after many more years of work. The tusk is now in the possession of a resident of Brooklyn.

RECENTLY E. J. Campbell, of Thurston County, Washington, announced that through scientific processes he had developed a stingless bee. The insect is said to give good honey.

Camera Reveals New Marvels of Science

AMAZING new uses for the camera as an instrument of scientific research have been found in the last few weeks.

At Ohio State University, Professor Wesley G. France has devised a microscopic motion-picture camera capable of photographing the movements of molecules in chemical action. With his machine Professor France succeeded in making pictures of the "Brownian movements" of particles of basic carbonate of lead, about 1/25,000 inch in diameter.

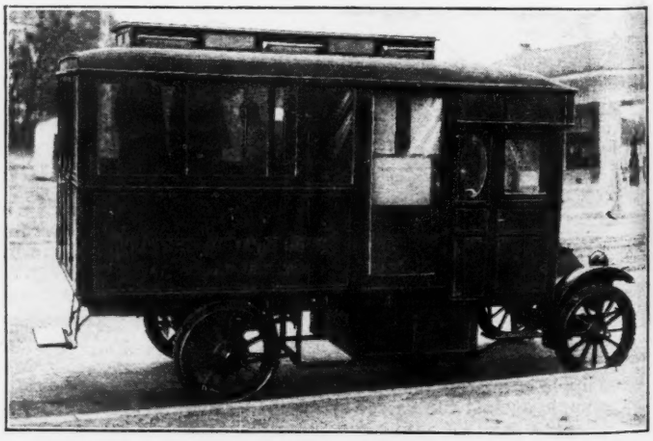
The particles were immersed in fluid and their irregular jerkings as the fast-moving molecules jolted against them were plainly visible when the pictures were thrown on a screen and enlarged.

Meanwhile two French scientists have demonstrated before the French Academy of Sciences a process of making X-ray motion pictures of the organs of the human body. The throbbing of the heart, the action of the lungs and the workings of the digestive organs are said to be disclosed perfectly by this process.

Another discovery, somewhat similar in application, has been made by Drs Evarts A. Graham and Warren H. Cole of the Washington University Medical School, St. Louis, Mo. This is an ingenious method of making X-ray pictures of the gall bladder that is said to furnish an infallible method of detecting gallstones.

Motorized Tailor Shop Calls at Your Door

OFFICIALS and residents of Washington, D. C., no longer need call on a tailor to get their trousers pressed. A telephone call will quickly bring the tailor's "wagon" buzzing up to the door and complete tailoring equipment within the car will press suits while the owner gets an extra sleep. This car probably is the first of its kind.



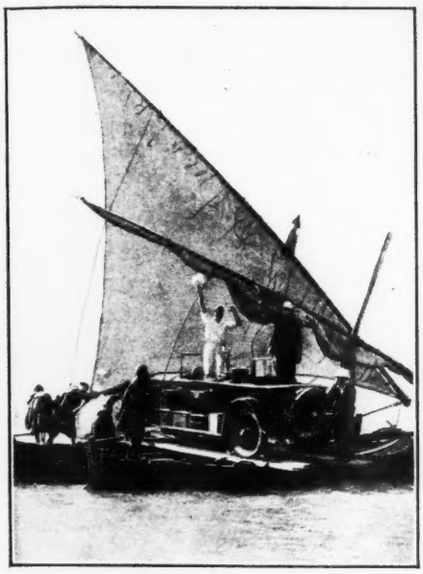
The tailor shop on wheels does "pressing at your door"

Ancient Boats Come to the Automobile's Aid

PRIMITIVE and modern methods were oddly linked recently when two African native sailboats were lashed together in order to hold an automobile that was ferried to the island of Djerba, Tunisia, North Africa.

After the boats were fastened together, planks were laid over them crosswise and the car driven on top of them. Only one triangular sail was used to propel this novel transportation contrivance, on account of lack of space.

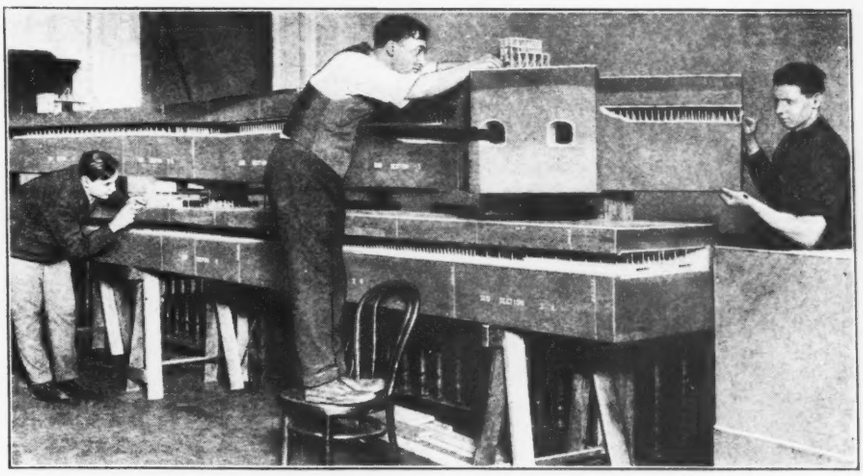
The trip was made without mishap and the natives seemed to enjoy transporting a white man's "iron horse."



Two native sailboats ferrying the auto

Sweeping the Clouds Away

UNDER some conditions aviators are able to brush small clouds out of the sky by flying through them repeatedly. A fair sized summer cumulus or fair-weather cloud sometimes may be obliterated by about 20 flights through it.



Huge Subway Model Is Evidence in Court

THE largest and most imposing model ever used as an exhibit in a trial in the Supreme Court in New York City was recently constructed to portray a section of subway to the jurors hearing the suit for $1,400,000 damages brought against the city by a construction company.

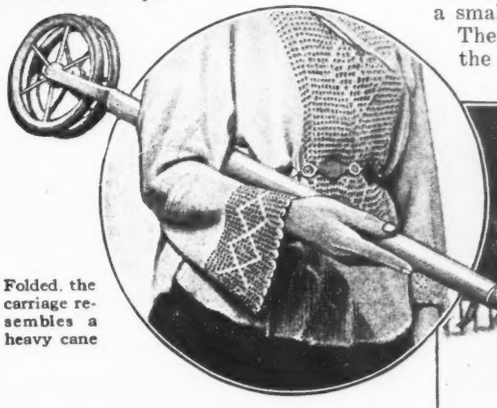
The model cost $8000 and is a complete reproduction of eight blocks of actual subway. Workmen spent the greater part of a day setting up the model.

Baby "Wheelbarrow" Folds into Small Space

THIS folding baby carriage is designed especially for greater convenience on a street car or in an automobile. It folds compactly into what resembles a large walking-stick with two rubber-tired wheels at the tip.

Opened for use, it affords the baby a comfortable swing seat. Safety is assured by a strap that goes about the infant's waist. The canvas seat is slung midway between the two wheels and the handles. Thus, in effect, the ingenious carriage is a small wheelbarrow.

The metal frame is arranged so that the carriage may be folded easily.



Folded, the carriage resembles a heavy cane

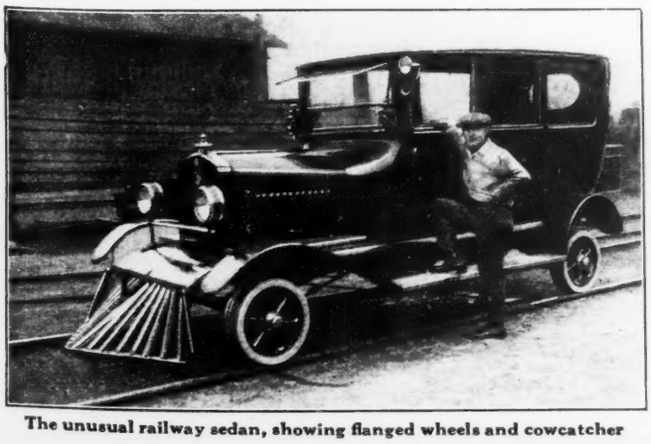
How the baby is wheeled

Sedan-Locomotive Runs on Railway Tracks

A RAILROAD sedan capable of a speed up to 80 miles an hour was constructed by the Southern Railroad Co. by equipping an automobile body with flanged car wheels and a cowcatcher. It was built for use in inspecting tunnels and for emergency wreck patrol duty.

There is no steering wheel and the operator merely has to control the speed and apply the brakes. The interior is lighted by electricity and heated from the exhaust muffler.

The sedan has complete equipment, including windshield, runningboard, fenders, and headlights.



The unusual railway sedan, showing flanged wheels and cowcatcher

City Lighting Laboratory

WITH 44 different kinds of street lights in actual operation, Columbus, Ohio, bids fair to gain national fame as America's street-lighting laboratory. Several cities have sent delegations there to study the demonstration.

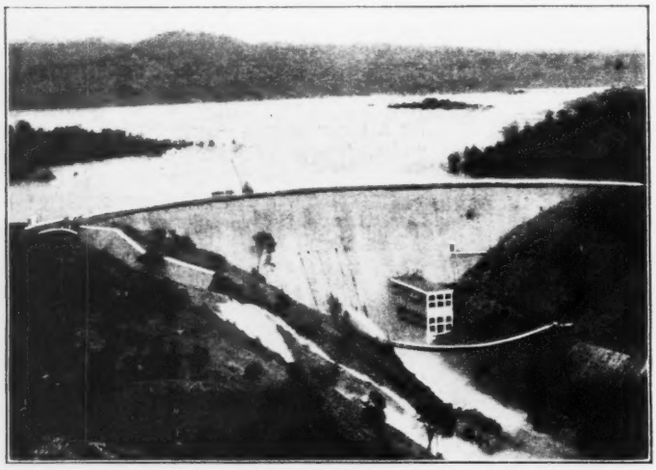
Largest Arch Bridge Will Be Half a Mile Long

Courtesy Messrs. Dorman, Long and Co., Ltd.

WHAT is to be the largest arch bridge in the world, costing over $15,000,000, will be constructed across the harbor at Sydney, Australia. The total length will be 3770 feet, more than half a mile, while the single arch in the center will have a span of 1650 feet. The head room at high water will be 170 feet, allowing the largest ocean liners to pass beneath.

The Highest Irrigation Dam in the World

AFTER two years' work on construction, the Don Pedro dam, near Modesto, Calif., highest impounding dam in the world, has been completed and its waters are being used for the irrigation of 240,000 acres of land formerly useless for cultivation.



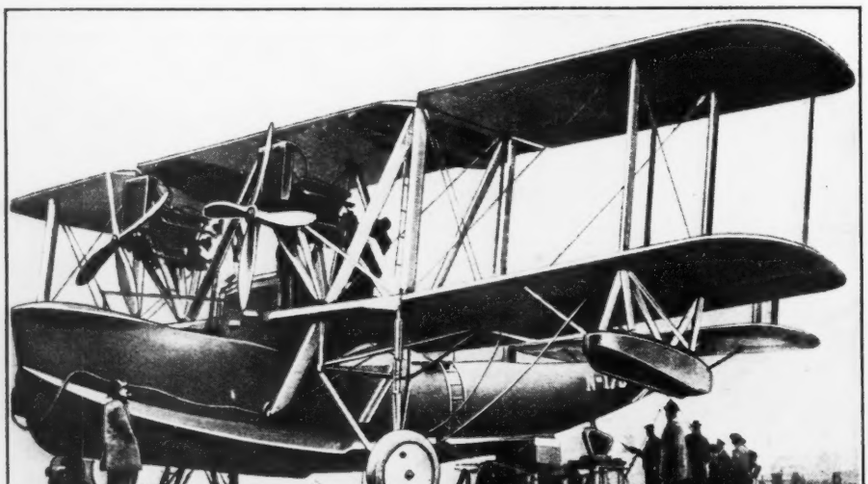
The dam, which cost about $4,500,000, is 280 feet high, 1040 feet long, 16 feet wide at the top and 177 feet wide at the base. The reservoir covers five square miles at an average depth of 280 feet. It is 14 miles long and has a maximum width of 4½ miles.

Three turbines capable of developing 20,000 horsepower are installed in the power house.

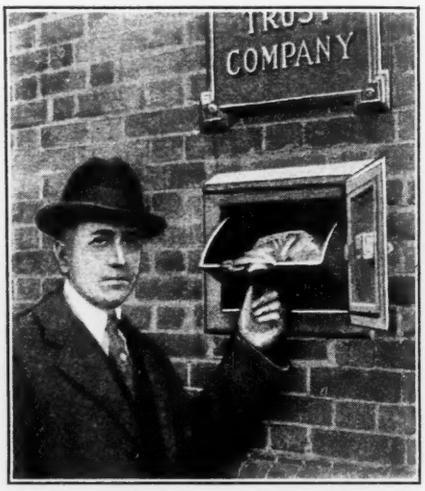
Giant Amphibian to Carry 12 Passengers

A TWIN-MOTORED amphibian airplane capable of taking off or landing on water or land is one of the new type of planes being developed for commercial purposes by the Civil Aviation Department of the British Air Ministry.

The plane is designed to carry 12 passengers, a pilot, and an engineer.



A view of the new passenger plane, showing twin engines of 360 horsepower each



Bank Chute Takes Money of Night Depositors

TO GIVE special service to patrons desiring to deposit money after banking hours, a Philadelphia bank vault company has invented an ingenious safety deposit chute that leads from the exterior wall of a bank building to the safety vault within. The outside opening of the chute is covered with a bronze door that can be opened only by the depositor who holds the key.

Whenever the outer door is opened, an alarm bell in the interior of the building rings. The depositor simply unlocks the door, pulls down a trap, and places his bag of money in this chute, which carries it immediately to the vault. The depositor then locks the outer door. The entire proceeding is said to require less than 10 seconds.

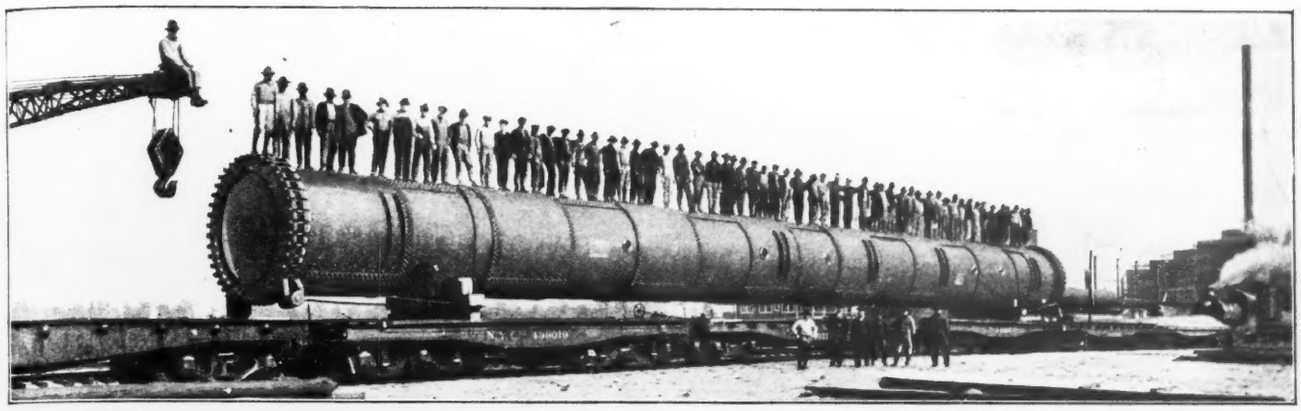
Special canvas bags fitted with padlocks are supplied to the depositors.

This system is designed to eliminate the problem of storekeepers, theater owners, and others who often find it necessary to keep large amounts of money where there is no safe.

Long Aerial Power Line

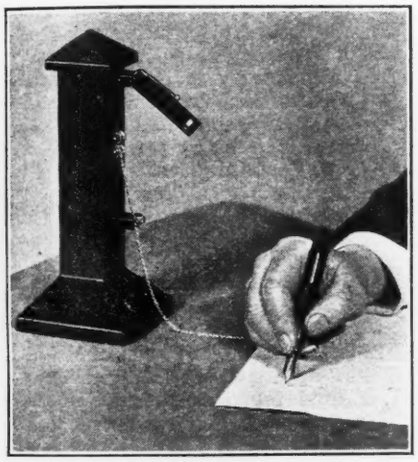
THE longest aerial power-line span, one of 6153 feet, is projected to carry electric power into Seattle, Wash., from across Puget Sound.

Five Cars Carry Huge Pipe on Long Journey



A RECORD pipe shipment was made recently from Alliance, Ohio, to Orange, Texas, when one section of pipe with an inside diameter of 8 feet occupied five flat cars for shipping. Its total length was 124 feet and 60 men could stand in line along the top.

This immense pipe is a creosote cylinder and its journey from Ohio to Texas took it over the lines of four railroads. The photo was obtained through courtesy of the Gulf Coast Lines.



Chained Fountain Pen Is Useful in Public Rooms

FOR use in reading-rooms, hotels, libraries, banks, etc., a fountain pen attached by a small chain to a neat-looking cabinet furnishes a first class writing instrument always in working order.

The fountain pen is normally held upright on the side of the stand. For use, a slight twist removes it from the cap and releases the body of the pen on the chain, which is fed from between two small rollers. When the desired length is obtained, the chain is locked by a slight pull to one side. After use a slight pull to the other side unlocks the chain, which disappears within the stand while the pen is returned to the cap.

American Buffalo Return to the Western Plains

A FEW years ago the bison, or American buffalo, of the Western plains, was threatened with extinction. Now, though, this danger is past. Where there were only 1100 head of bison in the United States and Canada 20 years ago, there are about 15,000 today—a fact that is due largely to the efforts of the American Bison Society in stopping the wholesale slaughter of the animals.

Mud Is no Obstacle to New Zealand Auto

FOR traveling the heavy mud roads of New Zealand a concern operating motor stages equipped their cars with special contrivances for towing automobiles out of mud holes under their own power.

The device consists of a steel drum containing 500 feet of wire rope with a breaking strain of four tons. This is mounted on the front of the car and is worm driven at the ratio of 96 to one by an auxiliary gearbox attached to the main gearbox. By attaching the cable to a stout pole and putting the drum in gear, the car is said to be able to pull itself through any kind of road at the respectable rate of 100 feet in five minutes.

Bridge Engineers Circumvent Mother Nature

AN UNUSUAL engineering feat was recently accomplished near Pueblo, Colo., when a contractor was forced to assemble and rivet a 100-foot steel bridge on one bank of a stream and then pull it into place because mountain floods had twice washed away all the supports.

The support work was hurriedly built, and a large tractor then pulled the structure into place by cable.

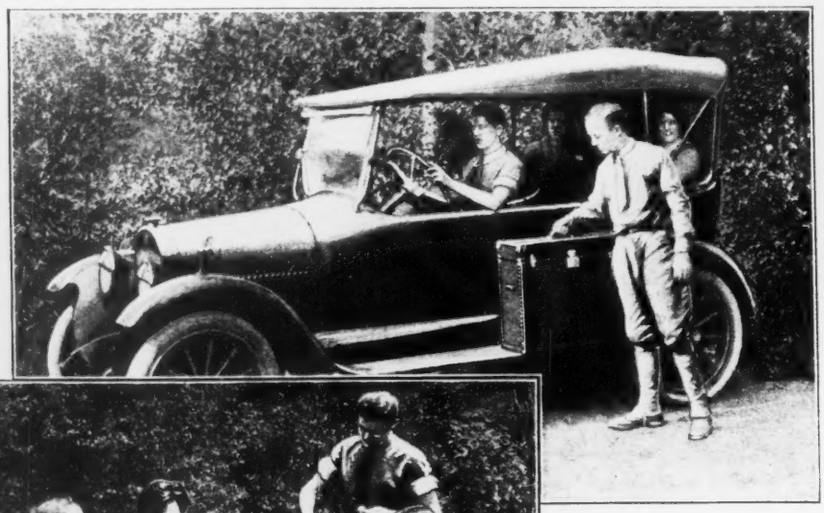
This bridge, near Pueblo, Colo., was pulled into place by tractor and cable

A Compact Outfit for Auto-Campers

MUCH of the pleasure of a summer auto-camping trip or a day's outing depends on the arrangements you make for comfort and convenience at mealtime on the road. To provide these conveniences in a compact form, a complete dining outfit, including table, chairs, food containers, utensils—everything necessary for the outdoor meal—has been devised to fit into a metal case that will ride on the runningboard of the car.

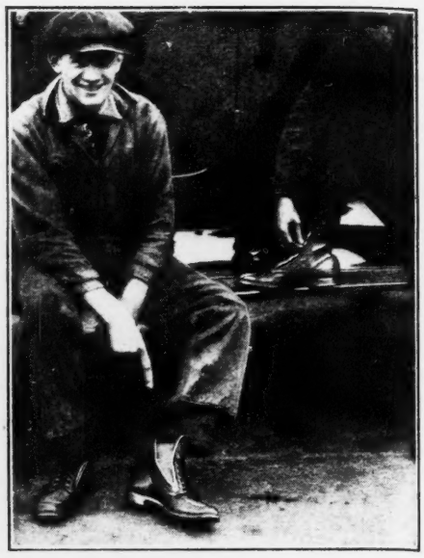
The large metal food containers hold food sufficient for six people for two days. The carrying case is used to form one side of the folding table. The case is supported at a comfortable height by removable legs, and the table top is attached to it. Six chairs fold into a small packing space.

When camp is broken, the complete outfit is quickly folded and packed into the case, which is equipped with a suitcase handle for convenience in carrying it back to the car, where it is strapped to the runningboard.



How the metal case rides on the runningboard

The complete outfit. The case forms a table-end



Automatic Metal Laces Applied to Shoes

THE interlocking steel lacing principle already applied to galoshes and tobacco pouches, now is being used for shoes. When such shoes are first bought, the laces are tightened to fit the foot. After that it is necessary merely to slide a key up or down to "lace" or "unlace" the shoe.

The automatic lacer is placed on the side of the shoe, which otherwise resembles the regular article.

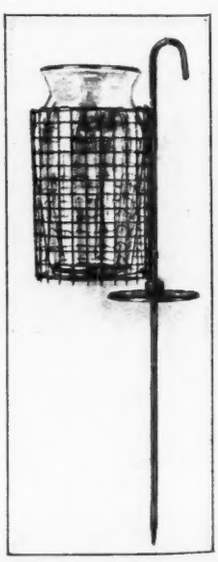
Substitute for Turpentine

CHEMISTS at the University of Washington are experimenting with oleoresin, a fluid found in pockets in the Douglas fir, in an effort to produce a substitute for commercial turpentine now obtained from our rapidly disappearing yellow pine.

Attractive Flower Basket for Yard or Greenhouse

A HANDY holder for displaying cut flowers attractively in the yard or greenhouse consists of a wrought-iron rod to which is fastened a wire basket holding a glass vase. The rod, pointed at the lower end, is inserted in the ground. A cast-iron plate at the surface affords a firm base when the rod is in the ground, and keeps it from tilting sidewise.

A hook at the top serves as a handle to be used in pulling the rod out, and a heavy coat of green paint preserves it from rust and at the same time adds to its attractiveness.



The flower basket supported by a metal rod

Know Your Car

When the Engine Overheats

WHEN steam begins to pour in clouds from the radiator of your car, it is a sure sign of an overheated engine. Such a condition often may result in serious damage, such as burned bearings or frozen pistons. If your engine overheats on the road, it is wise not to take the chance of continued driving. If you can't locate the trouble, stop at least long enough for the engine to cool. Then proceed slowly and cautiously. When you get the car home, the best way to find and remedy the trouble is by the following procedure:

1. See that there is plenty of water in the radiator.
2. Tighten the fan belt to assure brisk air circulation.
3. Inspect the hose connections to be sure there is no leak.
4. Drain, flush, and refill the radiator, then boil it out with sal-soda.
5. Drain out the old oil and refill with a fresh supply of the proper grade.
6. Remove carbon from the engine cylinders. Carbon is a frequent cause of overheating.
7. See that the spark is advanced to the proper point.
8. Set the carburetor for a mixture that is neither too rich nor too lean.
9. Make sure that the valves are not out of time.
10. Inspect the muffler to see that it is not clogged.

To Make a Balky Tie Slip through Your Collar

TO OPEN collars at the fold so that the tie may be slipped through easily when worn, an instrument known as a "collar cue" has been invented. The collar is inserted on the fork of the cue and pulled through. A tongue spreads the fold.

The World's Largest Safe

WHAT is said to be the largest safe in the world has been installed in the new Fourth Federal Reserve Bank at Cleveland, Ohio. The steel vestibule, or frame weighs 200,000 pounds while the door and the remainder of the gigantic vault weigh 300,000 pounds more.

The vault is 13 feet square and has an all-around thickness of four feet of the toughest chromium steel, presenting a hopeless problem to safe-breakers.

Light Paper Raincoat for Emergency Use

The design of the new paper raincoat

FISHERMEN, hunters, and hikers no longer need to be driven from their pleasures by sudden heavy showers. Emergency raincoats made of crepe paper especially treated will allow the fishing and hunting and hiking to go on without interruption.

When not in use the garment is folded into a small flat package weighing but eight ounces.

It is said to be rain- and windproof, affording adequate immediate protection in all sorts of weather.

Safety Tile for Stairs and Shops

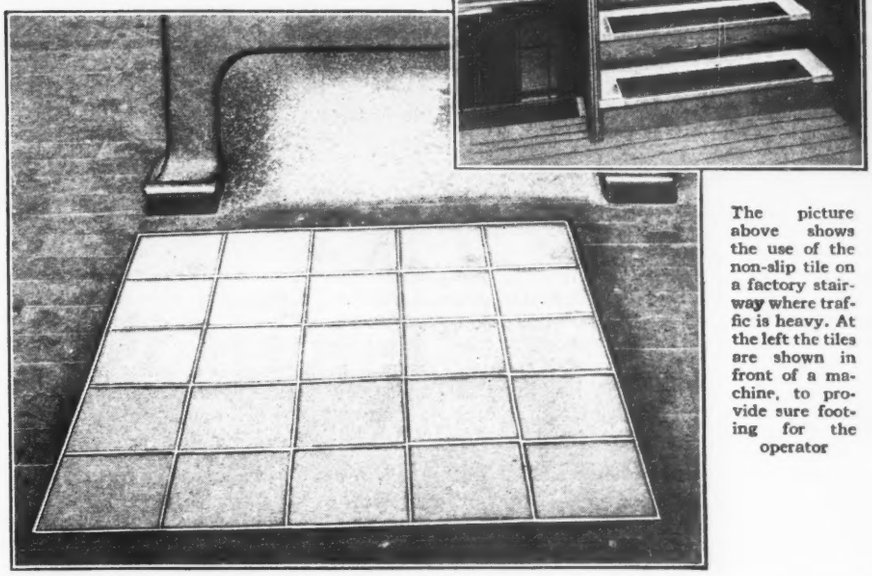
FOR stairways where the daily traffic of thousands of people scuff away the toughest of tread materials, necessitating frequent replacements, and where the danger of slipping accidents becomes a grave problem, there recently has been perfected a non-slip safety tile of an abrasive material which is commonly used for grinding.

The new product is intended specially for use in subway and railway stations, for ramps and factory floors where traffic is heavy, and for the floor in front of moving machinery where the operator's mind must be on his work rather than on his feet. It is expected to lessen materially the danger to operators of power saws, planes, and similar machinery with exposed moving parts.

The product may combine beauty with usefulness, for it holds unusual possibilities in color combinations.

Another tile very similar in construction is useful to eliminate the hazard of slipping where smooth, highly polished tiles are used for walking surfaces such as the dangerous edges of an indoor swimming pool, the slippery floor under the shower bath, or the floor of a hotel washroom.

Stair treads of the mat type are made by setting mosaic tiles 1 1/16 inch square in a reinforced asphalt composition.



The picture above shows the use of the non-slip tile on a factory stairway where traffic is heavy. At the left the tiles are shown in front of a machine, to provide sure footing for the operator

How Much Science Do You Know?

IT IS surprising how many fascinating facts of science may be found in the most commonplace objects and incidents of every-day life. Are you in the habit of asking questions and finding the reasons for these apparently unimportant things and happenings, or do you just take them for granted?

How much science do you know? The twelve questions that appear below offer you a chance to test your knowledge. Answer them to the best of your ability, then turn to page 119 for the correct answers.

See how nearly you come to making a perfect score.

1. What is specific gravity?
2. Why does a shotgun kick when it is discharged?
3. Is it possible to make a perfect vacuum?
4. Why do some stars differ in color from others?
5. What is the commonest chemical element in the earth's crust?
6. Why are tears salty?
7. What is an electric spark, and what causes it?
8. What is the difference between heat and cold?
9. How can fish breathe under water?
10. What is fog and how is it caused?
11. What part of the brain does the thinking?
12. Why is the tiger striped?

Baker by Night Is an Expert Fish Breeder by Day

A BAKER of bread by night, and a breeder of fish by day. Such are the odd titles of Louis Beldt, of St. Louis, Mo., whose vocation takes him to the bake ovens at 3 A. M. each day and whose avocation has resulted in his recognition as an authority on fish culture and in possessing one of the finest privately owned collections of rare and tropical fishes in the country.

Louis Beldt, St. Louis baker, in his aquarium, where he breeds fish as a hobby

Beldt has found that in hybridizing or cross breeding different varieties of fish, a female will give birth to five litters, at intervals of two weeks, without having been bred a second time. He has discovered also that it is necessary to separate the sexes of the live bearing fish before attempting any cross breeding, for if they ever breed their own kind, they persistently refuse a mate of any other species.

Fish fanciers and visitors from all parts of the country each Sunday file through Beldt's home-built aquarium, in which he has over 50 varieties from foreign tropical waters, to see his collection and to ask his advice on fish culture.

"Most people who begin keeping fish as a hobby believe that the water should be changed frequently," he says. "This is entirely false. The water in an aquarium need not be changed oftener than once a year if the tank is kept well balanced between fish and water plants. Plants give off the oxygen that fish need and the fish in turn produce carbonic-acid gas for the plants. Old water is clearer and cleaner than fresh.

"Snails also should be added to the aquarium. They are real scavengers and devour all decaying matter, animal and vegetable. They even eat up all the excess food that you put into the aquarium. Snails will do away with the unsightly green scum that sometimes forms on top of the water, similar to that which is found on ponds. This is a species of algae that grows on stagnant water surfaces."

Mr. Beldt has designed and manufactured an aquarium with a cast aluminum frame that he claims is an improvement over the old-style round fish-bowl. Such a bowl, he claims, results in high mortality among goldfish, because it refracts the light and draws the heat, while the opening at the top is too small to allow enough oxidation of the water.

Mr. Beldt's fish hobby has become almost self sustaining, and this baker of bread and breeder of fishes hopes soon to give up baking for good. He has orders for fish from all over the country.

A Soundproof Cover for the Typewriter

NEARLY any standard typewriter now may be converted into a noiseless one merely by placing over it a soundproof typewriter cabinet that permits the use of the machine without the usual clatter of keys. The paper and writing are visible through a glass cover.

Besides deadening the sound, the cabinet is said to protect the machine from dirt, dust, and accidental jars.

How the soundproof case fits over the typewriter, which remains visible through a window

New Umbrella Folds into a 10-Inch Bundle

A STANDARD-SIZE umbrella designed to fold into a compact bundle 10 inches long and 2½ inches in diameter is to be placed on the market. It is so small that it will fit into the coat pocket or into the smallest suitcase or traveling bag.

The metal handle telescopes, the double set of ribs folds toward the handle and the outer section of the cover folds against the inner half. The top is folded by turning the telescoped handle a few turns.

The opening is automatic. A few reverse turns are all that is necessary to release the handle so that it may be extended, a spring within causing the top to open and pull the cover tight.

New Cutting Process Saves Ford Huge Lumber Bill

A SAVING of from $50,000 to $100,000 a day and a big step toward conservation of the hardwood supply of the country recently has been effected by the Ford Motor Company through the discovery of a means for successfully utilizing every part of lumber except the knots, and thus increasing the useful output from each log from 30 to 50 per cent.

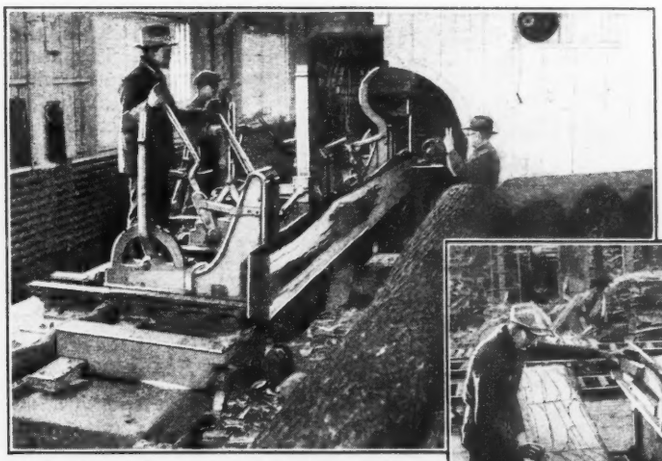
The new method accomplishes this saving by sawing automobile body parts direct from the unedged planks as they come from the log. The bark and sawdust are used in compositions that go to make steering wheels and other parts.

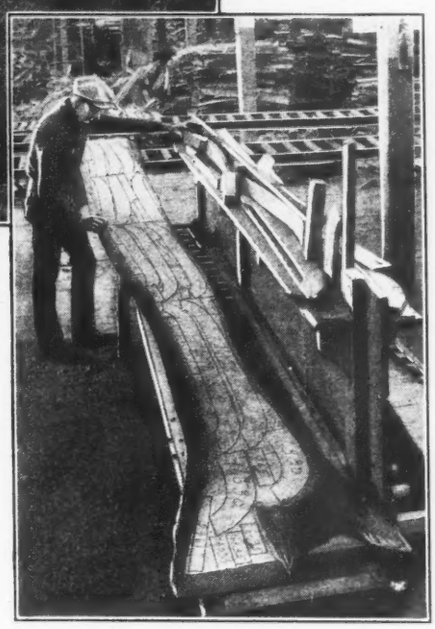
In the past, bodies have been made out of kiln-dried boards sawed to uniform size and grade. By this method much of the youngest and best wood has been wasted. In the many cases where the log has been curved or irregularly shaped, the scrap has exceeded the mercantile timber obtained.

In the new Ford system, planks with the bark left on are cut from a log in parallel planes. These are sent to "layout tables," where patterns for various parts are marked out until the plank is covered completely with patterns right up to the bark. Irregularities are taken advantage of in laying out curved or irregular parts.

Instead of trimming off a large piece to avoid a knot or check, the pattern men simply go around it. A high speed bandsaw then cuts out the various parts, following the markings.

Under the conventional methods the actual production of board feet in auto parts, in comparison to the wood content of the entire tree, is extremely low. The limbs and top, representing one third of the tree, are wasted before the log gets to the mill. Only from 55 to 60 per cent of the log actually is converted into body parts. The best use found for the limbs and top has been to send them through the wood distillation plant. By the new process they are sawed up and used for body parts.





Above: Sawing logs into parallel planes, with bark left on. At right: Layout bench where auto body parts are outlined on plank surface for sawing. Note how the irregular parts are made to fit into the irregularities of the log

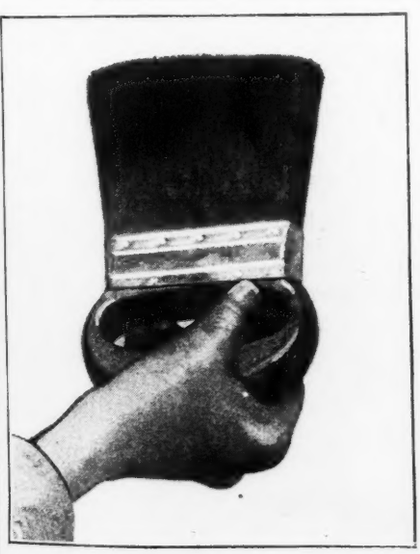
Gas-Tank Extension Facilitates Filling

BY MEANS of a new device that is attached to the automobile gasoline tank under the front seat, the necessity for the driver to first remove the seat cushion before refilling the tank with gasoline, is eliminated.

The apparatus consists of a flat aluminum neck, one end of which is inserted in the gas tank. The other end, projecting to the edge of the seat, has a nonleakable filler cap affording ready access to the tank, and gasoline gage that is always in sight.

Three strips of wood are fastened under the seat cushion so that the filling neck will not bulge the frame.

Filling the gasoline tank through the new extension without removal of the seat cushions



Saw Grip for Paint Brush

A NEW paint-brush handle shaped similarly to the handle on a saw, is said to eliminate strain and cramps usually experienced from the straight type handle, and also to allow a much freer arm and wrist movement in painting. The shape of the handle makes it possible for the hand to hold the brush in a relaxed natural position, thus preventing blisters. The tendency to slip from the hand is also said to be diminished.

The device was invented by one of the workmen in the factory of the concern that is now marketing the product.

IT WOULD take four months for an airplane flying 100 miles an hour to cross the United States if the earth were as large as the sun and its continents on the same scale.

"Horse's Hoof" and "Shoe Sole" Reproduced in Rocks

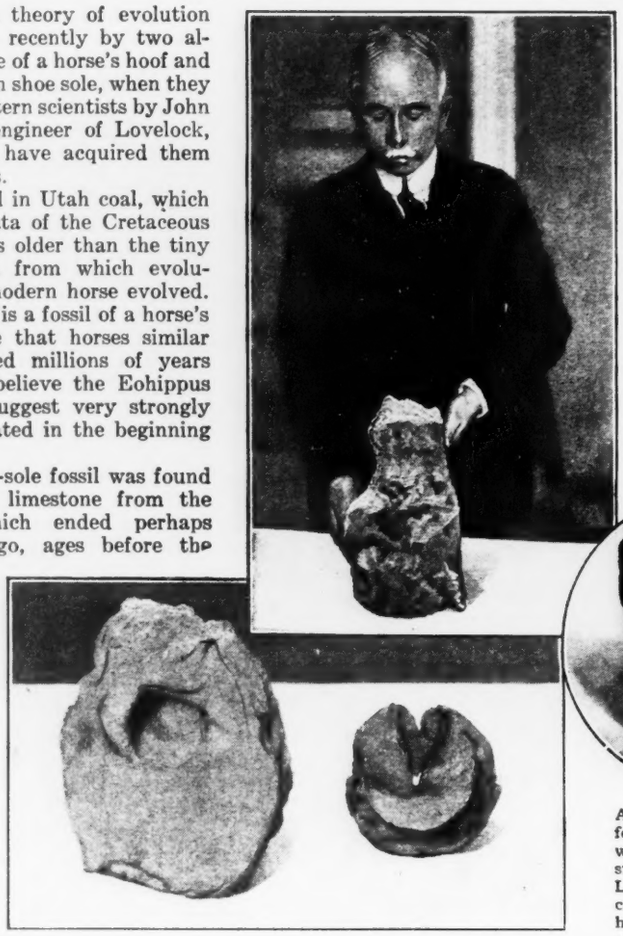
THE Darwinian theory of evolution was challenged recently by two alleged fossils, one of a horse's hoof and one of part of a human shoe sole, when they were exhibited to Eastern scientists by John T. Reid, a mining engineer of Lovelock, Nev. He is said to have acquired them from their discoverers.

The first was found in Utah coal, which came from earth strata of the Cretaceous Age, millions of years older than the tiny three-toed Eohippus, from which evolutionists believe the modern horse evolved. If the object actually is a fossil of a horse's hoof, it would prove that horses similar to modern ones lived millions of years before evolutionists believe the Eohippus lived. This would suggest very strongly that horses were created in the beginning as they are today.

The supposed shoe-sole fossil was found in Nevada, in blue limestone from the Triassic period, which ended perhaps 100,000,000 years ago, ages before the appearance of the ape-like creatures from which man is said to descend. Evolutionists are certain that man has existed for not more than 500,000 years. If the object is what it is claimed to be, a strong presumption would arise that man did not evolve from lower animal forms.

The "shoe sole" has what appears to be double stitching round the edge. These "stitches," microphotographs show, are regularly spaced, and shoemakers have pronounced the whole apparently the work of a very skilful artisan. The surface is leather-colored.

The "fossil" was termed by Dr. J. F. Kemp, professor of geology at Columbia University, and Dr. William D. Matthew, paleontologist of the American Museum of Natural History, in New York, "the most remarkable imitation of man's handiwork by Nature" they ever had seen.



Above: "Shoe-sole fossil" found in ancient rocks. It has what appears to be double stitching around the edge. Left: The "horse-hoof fossil" compared with modern horse's hoof. Top: John T. Reid, engineer, exhibiting the "hoof"

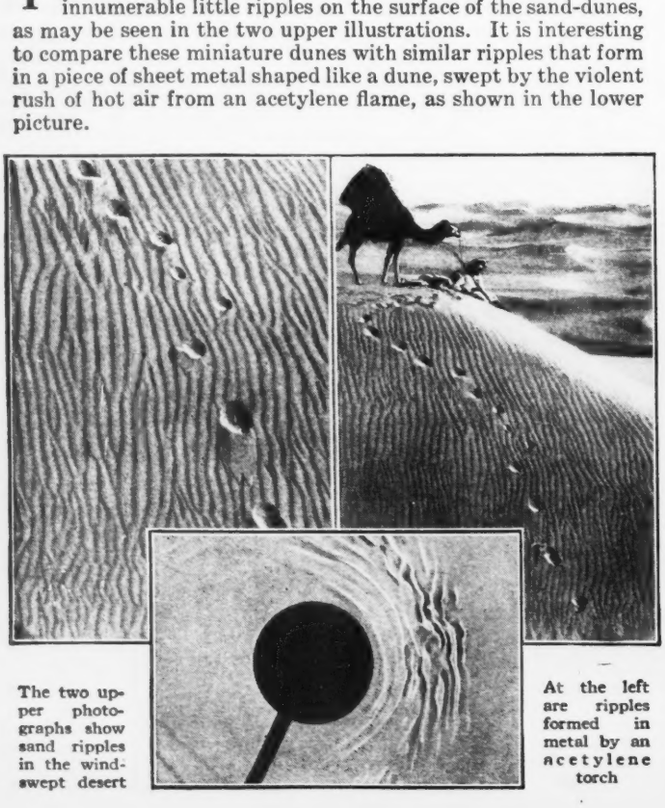
A Substitute for Platinum

PLATINUM is even more valuable to the scientific worker than it is to the jeweler because of its power of resisting corrosion. Its cost, though, is so great that it must be used sparingly.

Recently, however, science has found an effective and very much cheaper substitute for platinum in certain alloys of chromium and in iron electroplated with chromium. Any of these may be used for such purposes as serving for negative poles in electro-analytic work, also it is harder than platinum, hence, not likely to be harmed by handling.

Ripples of Sand and of Metal

THE regular winds that sweep over the Sahara Desert create innumerable little ripples on the surface of the sand-dunes, as may be seen in the two upper illustrations. It is interesting to compare these miniature dunes with similar ripples that form in a piece of sheet metal shaped like a dune, swept by the violent rush of hot air from an acetylene flame, as shown in the lower picture.



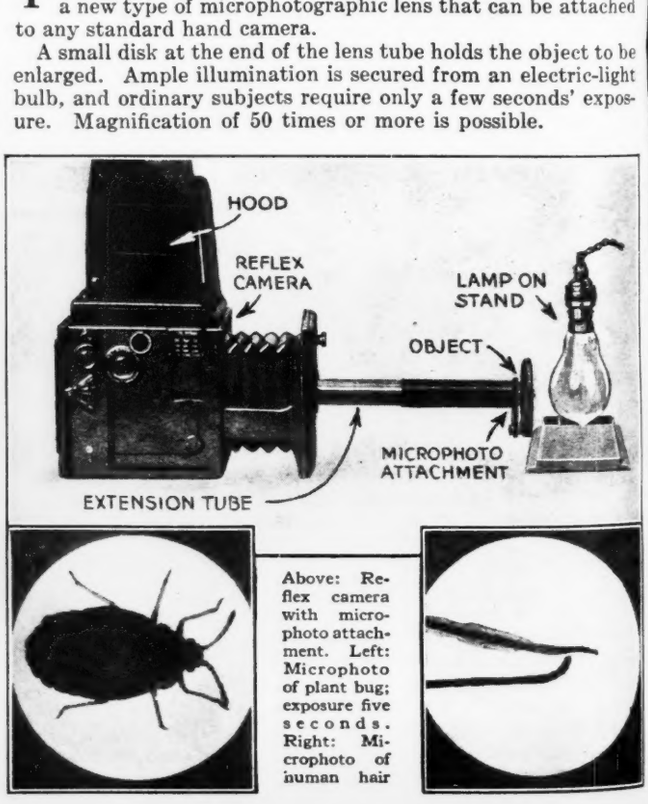
The two upper photographs show sand ripples in the wind-swept desert

At the left are ripples formed in metal by an acetylene torch

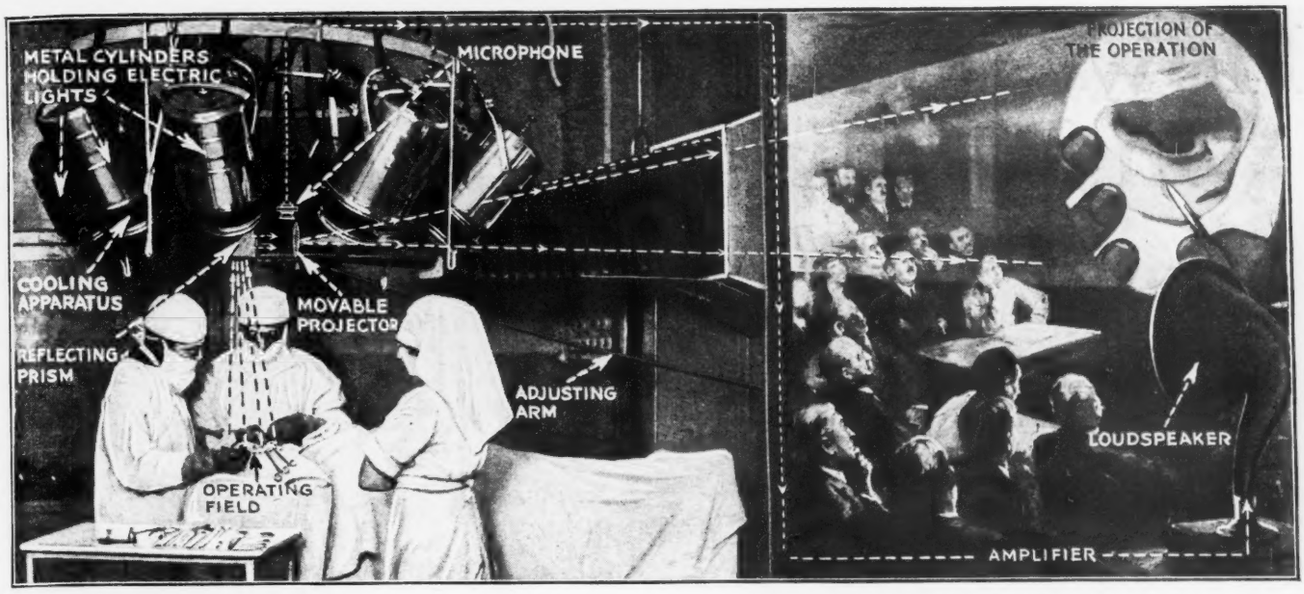
Microphoto Camera Attachment

THE work of taking magnified photographs is simplified by a new type of microphotographic lens that can be attached to any standard hand camera.

A small disk at the end of the lens tube holds the object to be enlarged. Ample illumination is secured from an electric-light bulb, and ordinary subjects require only a few seconds' exposure. Magnification of 50 times or more is possible.



Above: Reflex camera with microphoto attachment. Left: Microphoto of plant bug; exposure five seconds. Right: Microphoto of human hair



Surgical Operation Projected on Classroom Screen

BY AN invention perfected by a French hospital interne, the most delicate operations may be projected and enlarged on a screen in a lecture room some distance from the operating room. The projected picture is said to show every detail of the operation and all the objects in natural color, while the operating surgeon explains his movements to his distant "audience" by means of a loudspeaker.

The invention has been made possible by a method of absorbing the intense heat of the lamps required to light the operation for its projection. Heretofore the harmful effects of this heat on the patient has baffled attempts at stereopticon projection.

The apparatus consists of a series of metal cylinders containing powerful electric lamps with metal filaments. These cylinders are cooled by water chambers, the upper and lower surfaces of which are transparent. The water is kept in constant circulation by a motor pump.

An optical arrangement, including a projecting lens and a reflecting prism, is set from two to three feet above the field of operation, on which the light of the lamps is focused. By means of an adjusting arm the projector and lamps can be moved. A microphone above the surgeon carries his words to the lecture room.

Loudspeaker and Automatic Call Recorder for the Telephone

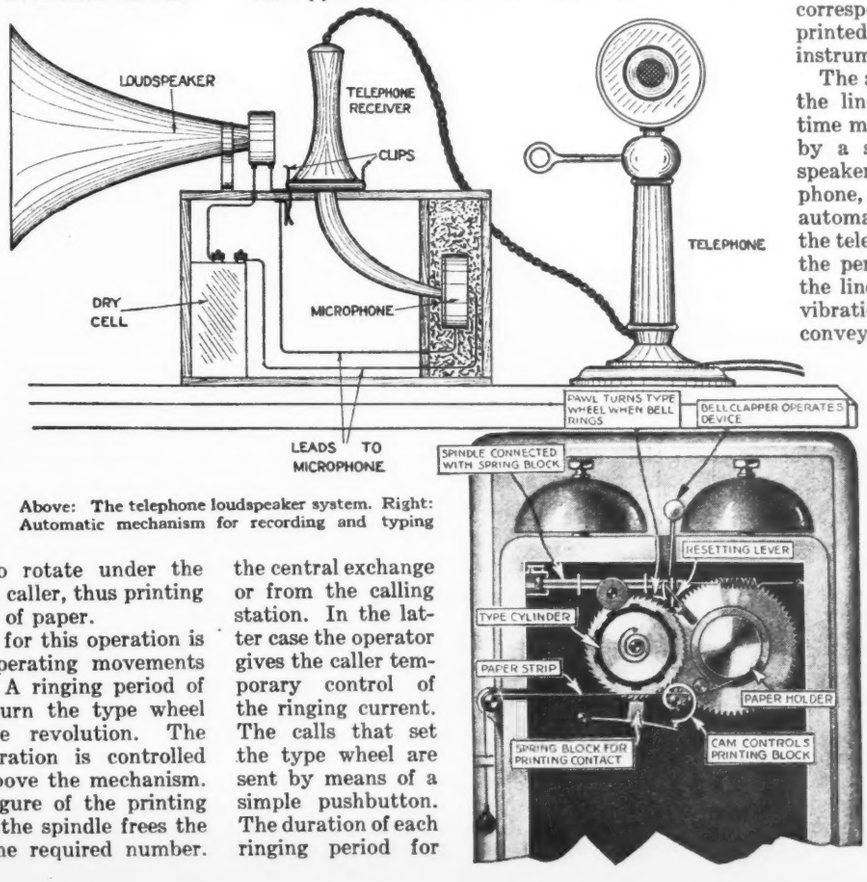
TWO remarkable automatic devices, both designed to do away with proverbial inconveniences in telephoning, have been perfected within the last few weeks.

One is a "telephone telltale" which, in the absence of its owner, automatically prints on a slip of paper the number of an incoming call. The other is a loudspeaker device to eliminate the necessity of "holding the line."

The telltale is a clockwork attachment connected with the bell mechanism of the telephone instrument. The vibrating movement of the bell causes a small type wheel to rotate under the control of the distant caller, thus printing the number on a slip of paper.

The motive power for this operation is derived from the operating movements of the bell spindle. A ringing period of three seconds will turn the type wheel through a complete revolution. The actual printing operation is controlled through a spindle above the mechanism. When the desired figure of the printing block is in position, the spindle frees the block that prints the required number. At the same time the paper is fed forward for further operations.

The apparatus can be controlled from the central exchange or from the calling station. In the latter case the operator gives the caller temporary control of the ringing current. The calls that set the type wheel are sent by means of a simple pushbutton. The duration of each ringing period for setting this wheel to required figures is determined from the caller's own telltale indicating device, which points to figures corresponding to those to be printed on the absentee's instrument.



Above: The telephone loudspeaker system. Right: Automatic mechanism for recording and typing

The annoyance of "holding the line" for any length of time may be done away with by a simple form of loudspeaker operated by a microphone, which, in turn, is automatically energized by the telephone receiver. When the person at the far end of the line begins to speak, the vibrations in the receiver are conveyed to the microphone, which is connected with a dry cell.

The emitted sound waves vary the electric resistance of the carbon particles contained in the microphone and set up fluctuations in the current from the dry cell. These changes operate the loudspeaker, which magnifies the conversation sufficiently to be heard a considerable distance.

The apparatus is designed especially for use in a private office.

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Whenever a prospective home-builder comes to me for advice on how to save money in construction, my first thought is to let that statement speak an effective answer. For when you come right down to it, saving consists largely of cutting out unnecessary waste — waste in materials, workmanship, architecture, and waste represented in spending more than you can afford on things you don't need.

"How can I build a small home and save money? How can I make my savings go further? How can I spend less money and get more in return?"

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The secret lies first of all in getting the right attitude—in regarding home-building as a business enterprise, to be undertaken in a businesslike manner. When you begin to look at it as an investment for your money, then only will you begin to realize that every dollar spent should produce full value in return.

To save by preventing waste of material, workmanship and time, the first essential is to find an honest, dependable contractor whom you can rely upon as your responsible executive to carry out your plans within the price you can afford to pay.

The contractor who will dishonestly substitute material of inferior quality at the price of durable material, or who will attempt to cover up vital errors in construction and slipshod workmanship, may cost you hundreds of dollars. In fact, he may even turn your best-laid plans for sound investment into financial disaster.

When you are ready to build, make inquiries and find out the reputable contractors in your community. From these you can ask for competitive bids, and thus you can bargain for the one who will give the most for the least money. Unless you are experienced in buying materials and handling labor, don't attempt to build your home by the so-called "day labor" plan, that is, by letting the many sub-contracts for the work yourself. Your lack of knowledge is likely to lead you into costly disputes and into needless expense in the purchase of materials.

YOU are the owner and proprietor of the business enterprise that is to be your home. Let a single general contractor be your executive in charge of the work. He will be your expert to buy your materials economically and to let the sub-contracts for such things as heating, plumbing and electric wiring. He is the man who will be responsible for the correction of errors and for turning over to you the completed home in satisfactory condition, and at a cost within the original estimates.

But you cannot expect to make your general contractor responsible, no matter how honest and conscientious he may be, unless at the outset you provide him with complete, carefully prepared plans and specifications to execute.

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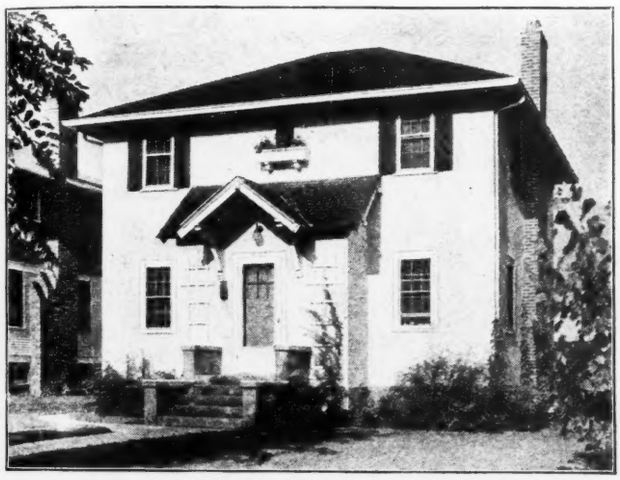

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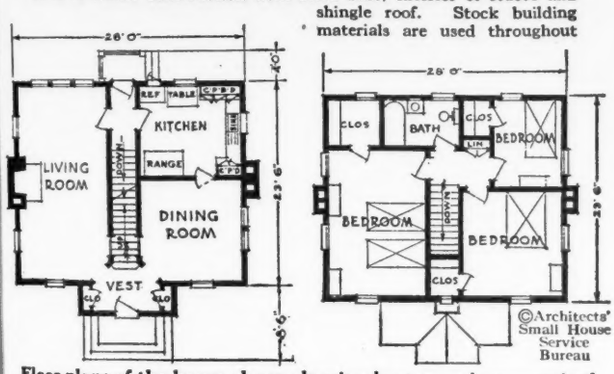

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This is an extreme case, yet many home builders are tempted likewise to plunge into little luxuries and unnecessary extras that usually add up to an astounding total in the end.

You will be surprised how much money you can save not only by firmly refusing to depart from your charted course, but actually by limiting your requirements, cutting out all items that you can do without for the present and that can be added some time later as your finances warrant them.

Suppose, for example, you are to build a $6000 home. Your specifications, we'll say, call for an exterior of stucco. You can save from $125 to $300 at one stroke simply by substituting an exterior of wood siding. Or, if the specifications call for brick, the saving may be more than twice as great.

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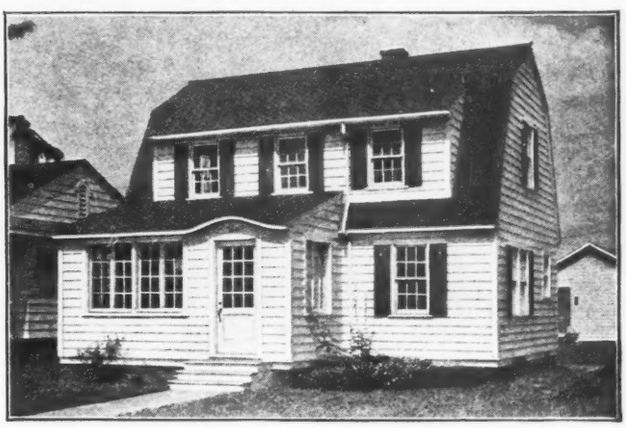

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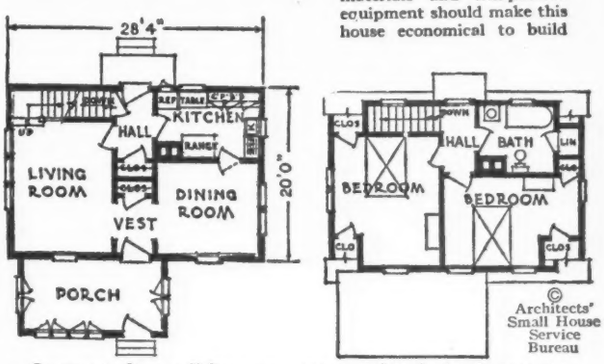

Compact plans call for no unnecessary breaks in the exterior

In planning the foundation, you will have to be guided to a great extent by the building codes in your community. Unless restrictions prevent, a nine-inch foundation wall of brick or concrete, soundly constructed, will serve amply for a small home. You can save money by using this thinner wall rather than a 12-inch wall.

A full cement basement is not absolutely essential. It is something that can

(*Continued on page 113*)

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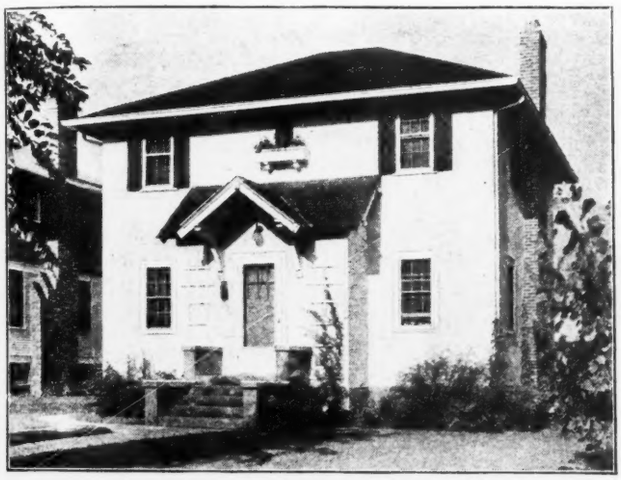

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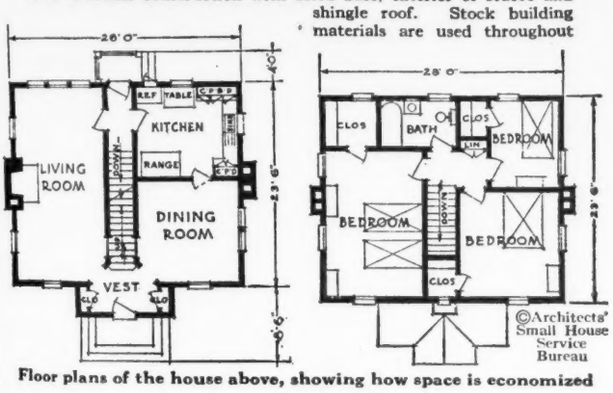

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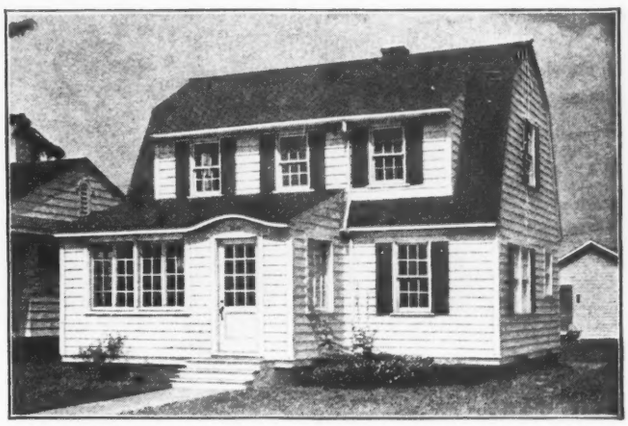

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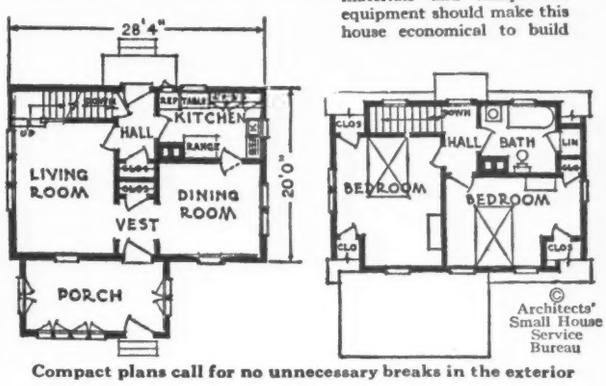


Compact plans call for no unnecessary breaks in the exterior

In planning the foundation, you will have to be guided to a great extent by the building codes in your community. Unless restrictions prevent, a nine-inch foundation wall of brick or concrete, soundly constructed, will serve amply for a small home. You can save money by using this thinner wall rather than a 12-inch wall.

A full cement basement is not absolutely essential. It is something that can

(*Continued on page 113*)

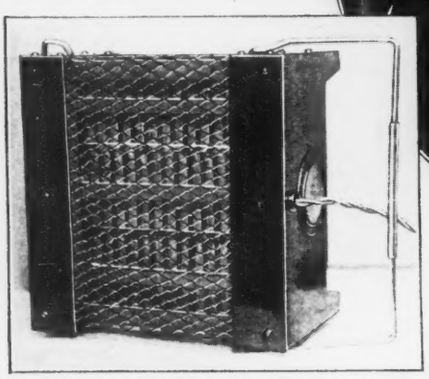
The Last Word in Radio

A Résumé of Important New Developments and Inventions

By Jack Binns
America's Most Popular Writer on Radio

A REMARKABLE filament material that is expected to revolutionize vacuum tubes has been discovered in the laboratories of one of the big electrical corporations. It is predicted that this material, when the experimental work is complete, will permit the manufacture of a tube that will practically reach the goal all experimenters have sought to attain—cold electron emission. Even in its present laboratory stage there is no visible glow from the filament when the tube is in operation.

Ever since the three-element vacuum tube was first produced, experimenters have tried to eliminate the unwanted light and heat that are by-products of tube operation. The only thing used in radio work is the stream of electrons shot off from the filament of the tube. These form a pathway for the current to the plate. The problem of perfect tube efficiency has been to get this electronic stream without consuming energy in making the filament glow to a white or red heat.



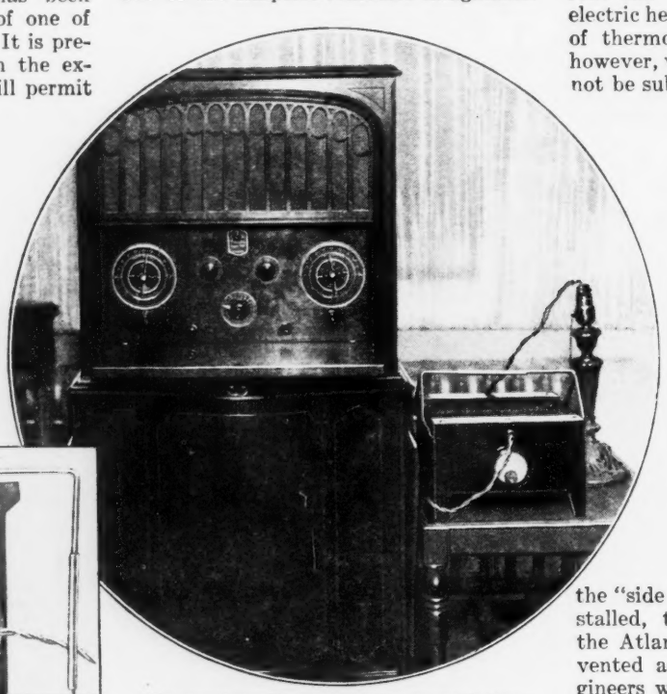
Side view of the thermoformer, showing thermocouples that are heated by electric coils, producing direct current for the radio set

The first step toward the goal of perfect tube operation came with the oxide-coated filament. The next important step came with the introduction of the thoriated-tungsten filament.

Now we shall have a new filament. Its nature is still secret. There is much to be done with it before it can leave the laboratories, but I am reliably informed that it will permit four times as many tubes to be operated off the same battery as can be operated with the thoriated-tungsten filaments. It means a really portable set.

Radio without Batteries

FOR several years scientists in the big commercial laboratories have searched for a means of employing the ordinary house current to operate radio sets. The big drawback always has been the objectionable hum accompanying reception, irrespective of whether direct or alternating current was used. Investigators have concentrated their efforts upon eliminating this hum. In doing so they overlooked one of the simplest remedies imaginable.



The new thermoformer operating a super-heterodyne receiver of the largest commercial cabinet type from an ordinary electric-light socket

This remedy has been discovered by R. E. Sabin, a chemical engineer, in the invention of an apparatus called the "thermoformer." It relies upon the fact that heat will generate electric current, if two dissimilar elements are joined and heat applied at the point of their junction. Such current is absolutely steady and uniform. Each unit of two such elements is known as a thermocouple. The device can be used to supply B-battery voltage as well as to light the filaments.

The remarkable feature of the invention is that it can be employed on farms or at other places where electricity is not available. For use where electric-light current can be had, the thermoformer has electric heating coils underneath the series of thermocouples. There is no reason, however, why an ordinary oilstove should not be substituted for these heating coils.

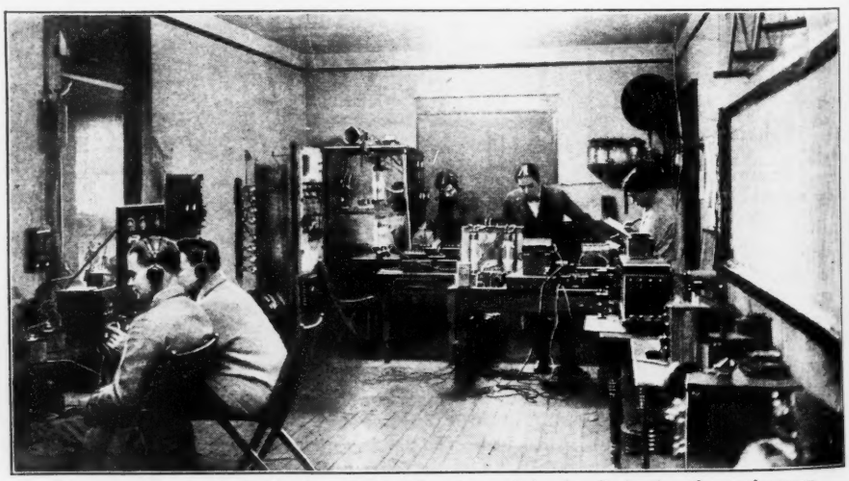
Across the Sea

"HELLO, Washington! Is Mr. Coolidge there? This is King George of England, talking from London!"

The next miracle of radio undoubtedly will take the form of such a conversation flung across the ethereal pathways over the Atlantic Ocean. The epoch-making day is now not far distant. When it dawns it will usher in a new triumph for American genius.

The big British Post Office radio station at Hillmorton, near Rugby, now being constructed, is to have a 200-kilowatt tube transmitter of the "side band" type. As soon as it is installed, two-way communication across the Atlantic by the two-way system invented and developed by American engineers will be made possible on a practical basis. The wonderful thing about it is the ease with which radio and land line telephone systems can be hooked up together and function automatically. When the British station is ready, you will be able to talk to friends in England over the ordinary telephone in your home.

Conversation across the Atlantic has been carried on daily for more than a year. It has been a one-sided affair, however, because the only transmitting station is the one at Rocky Point, L. I.



Interior view of the University of Illinois' radio laboratory, where experiments are being conducted that may revolutionize broadcast transmission by eliminating the carrier wave, preventing the interference of "squeal" radiation from receiving sets, and reducing costs

This giant superheterodyne receiver, operating on 8, 9, 11, of 14 tubes, was designed by F. R. Greene, an amateur of New York City. The set requires no ground nor aerial, and cannot be operated with less than eight vacuum tubes

Improved Transmission

EVER since broadcasting became popular, the attention of almost every radio fan has been concentrated on receiving apparatus. Improvements in transmission have passed by almost unnoticed, despite their great importance. There can be no quality reception unless the transmission is equally good.

Experiments recently made in the University of Illinois' radio laboratories may change the entire system of broadcast transmission by eliminating the carrier wave. Greater efficiency possibly will result from the new system, but more important than all else will be the elimination of "squeal" radiation.

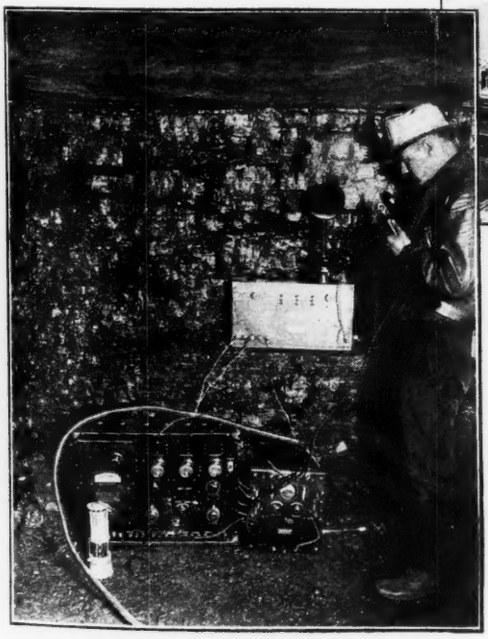
Radio and the Airship

EXPERIMENTS with short-wave radio by the engineers of the U. S. Naval Research Laboratory under the direction of Dr. A. H. Taylor, have been so successful that a special transmitter has been designed to operate on wave lengths of 80 and 100 meters.

The first of these has been installed on the airship *Shenandoah*. It is operated by a 24-volt storage battery, which will insure several hours' transmission in emergencies. During normal use the battery is kept charged during operation. It will be used chiefly for radio-telegraph communication of the continuous-wave type.

For short-distance telephone communication, as when landings are to be made, it will supersede the main set. Both sets can be operated simultaneously while the big airship is flying or hovering in the air.

By the way, radio will assume a very important rôle in navigating the new airship ZR-3 across the Atlantic this fall.



Recent tests by the Bureau of Mines at Pittsburgh have demonstrated that a system of wired wireless can be used effectively for transmission and reception of messages several thousand feet underground in a mine. The photograph above shows transmitting and loudspeaker receiving sets in a mine

Reginald Gourand, of Paris, France, at work on a radio transmission set, which he claims will be powerful enough to permit President Coolidge and President Millerand of France to exchange greetings across the Atlantic

Inventors Are Active

THE feverish energy concentrated on the problems confronting the development of radio is illustrated in the records of the U. S. Patent Office. A year ago radio patent applications swamped that overworked institution, and threw it into a state of chaos.

At the present time approximately 40 patent applications reach the radio division of the Patent Office every week. In addition, about 50 amended applications are filed each week. The trend of the times is emphasized in the fact that inventions relating to radio transmission are very heavy. There also are many inventions relating to the transmission of photographs by radio, and some for television—the method that some day will permit us to see distant events by radio.

A remarkable new substitute for the radio B battery, shown above, is attached to an electric-light socket. It is known as the "super-Ducon," and is the creation of Harry W. Houck (right) a radio engineer. The apparatus Mr. Houck is holding is an early form of his invention. William Dubilier, famous radio inventor, is seen at the left demonstrating the invention in its final form. The device can be used with either direct or alternating current, and is said to consume less current than an electric light. It is composed of a rectifier and a simple arrangement of resistances and condensers to filter out the hum of the current from the lighting circuit

Secrecy Is Promised

SECRECY in radio communication is said to be achieved in a system recently exhibited by John Hays Hammond, Jr., before officials of the Italian Government. The method also is said to permit the simultaneous transmission of more than one message on the same wave length.

These effects are said to be produced by utilizing several super-audible waves to modulate the carrier wave in a combination known only to sender and receiver. Only receivers tuned to this combination can receive the signals, and, since the possible number of combinations of wave lengths is infinite, the chance of other receivers picking up the message is virtually nil.

How to Build a 5-Tube Loop Set

By Joseph Calcaterra
Radio Editor
POPULAR SCIENCE MONTHLY

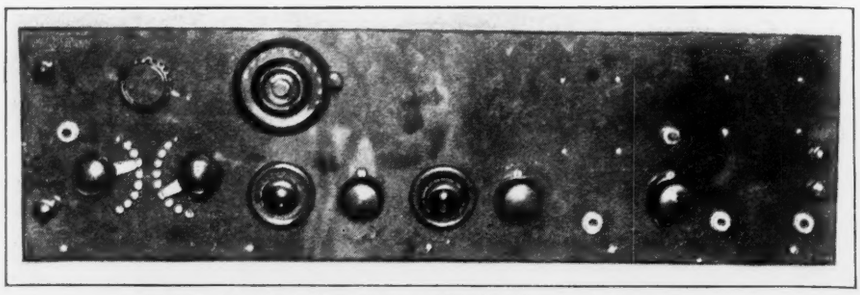
HERE is a set that reduces static to a minimum, reduces interference from other stations, and insures improved tuning. It offers distance and volume without the necessity of an outside aerial. It is an excellent set for the crowded districts of the larger cities.

A small inside aerial system offers selectivity and enables the operator to tune station to station without interference. The directional characteristics of a loop also serve to eliminate static noises and interference from poorly operated near-by receivers.

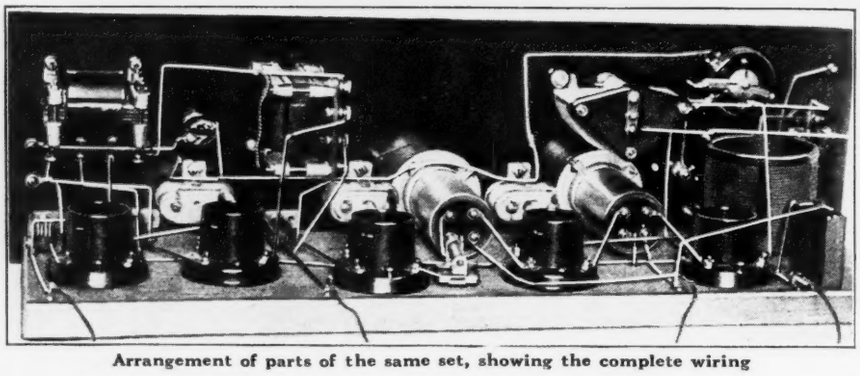
The set uses two stages of tuned radio-frequency amplification, a detector, and two stages of audio-frequency amplification. It is adaptable for use either with an indoor aerial consisting of 10 to 30 feet of insulated wire strung through the rooms of an apartment, or with a loop aerial.

The circuit calls for five tubes. Storage-battery tubes give best results.

Number 1 is the aerial post; No. 2 the ground post; No. 3 the tuning coil, consisting of 60 turns of No. 22 d.s.c. wire wound on a tube three inches in diameter and three inches long. Taps are taken at every 10 turns, the taps being arranged in a line down the front of the coil.



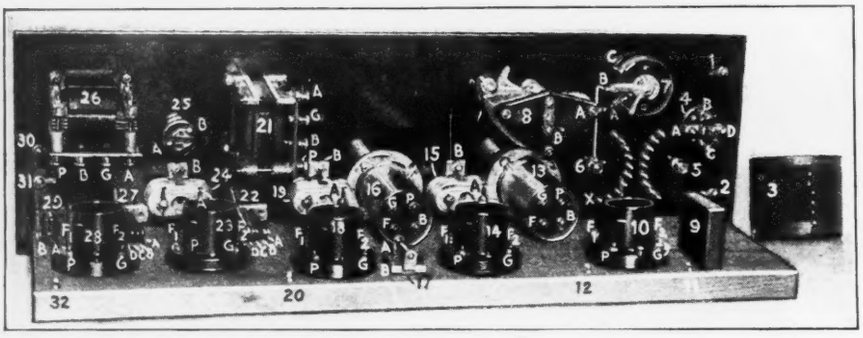
Panel view of the five-tube receiver for loop-aerial reception



Arrangement of parts of the same set, showing the complete wiring

NUMBER 4 is a double-circuit jack. *A* and *D* are the outside springs; *B* and *C* the inside springs. Numbers 5 and 6 are inductance switches. Switch 5 is provided with seven switch points; switch 6 with eight switch points. Two switch stops are provided for each switch.

Number 7 is a standard potentiometer, preferably of 400 ohms. Number 8 is a .0005-microfarad (approx. 23 plates) Vernier variable condenser. The terminal of the stationary plates is marked *A*, while the terminal of the rotary plates is marked *B*. Number 9 is a one-microfarad fixed condenser.



Here the parts of the set are numbered and lettered to correspond with the symbols in the wiring diagram. The tuning coil, 3, is placed at the side of the receiver to expose taps and switch points

Numbers 10, 14, 18, 23, and 28 are the vacuum-tube sockets. The filament terminals of the sockets have been marked F_1 and F_2.

Number 11 is the negative B-battery terminal, consisting of a soldering lug and screw in place of the usual binding posts.

Number 12 is the positive B-battery terminal for the radio-frequency stages. Numbers 13 and 16 are radio-frequency variotransformers. Ordinary fixed transformers may be used instead, but will not give as good results.

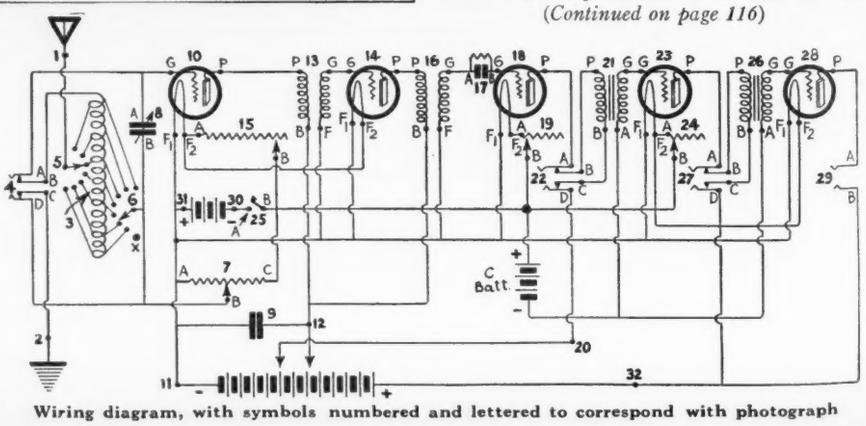
Numbers 15, 19, and 24 are six-ohm rheostats. Number 17 is a combination grid leak and condenser. The grid condenser should have a capacity of .00025 microfarad, while the grid leak should have a resistance of from two to five megohms. Number 20 is the positive B-battery terminal for the detector stage.

Numbers 21 and 26 are standard audio-frequency amplifying transformers. The grid return terminal is marked *A*, although in many transformers it is marked *F*. Numbers 22 and 27 are standard double-circuit jacks; No. 29 a standard single-circuit jack; and No. 25 a battery switch. Number 30 is the negative A-battery terminal; No. 31, the positive A-battery terminal; No. 32, the positive B-battery terminal for the audio-frequency amplifier stages.

THE first step in wiring is to connect the corresponding switch points 5 and 6. Connect the two top switch points of each switch; then, going down the line, connect one switch point of switch 5 with the corresponding switch point of switch 6. Since there is one more switch point on switch 6 than on switch 5, this extra switch point will be left unconnected. This is the "blind" switch point on which switch 6 is set when it is to be disconnected from the coil.

Now place the coil in position in front of switch points. The top of the winding is connected with the wire connecting the first two switch points of both switches. The other taps down to the end of the

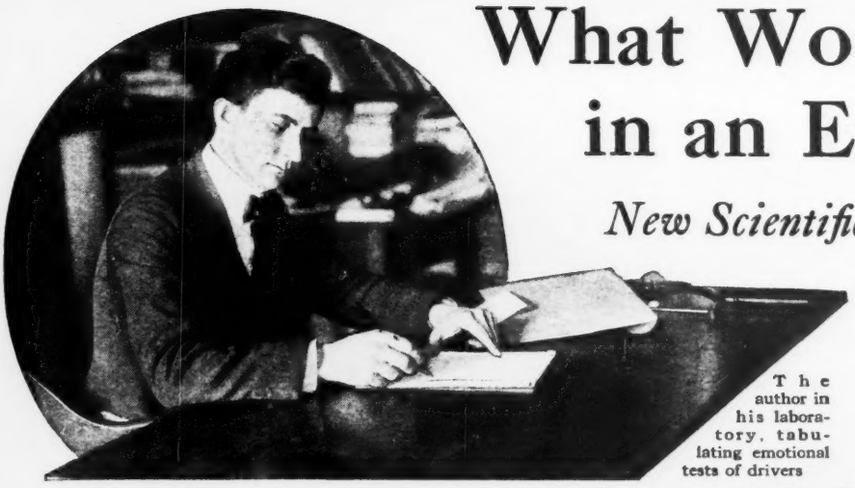
(*Continued on page 116*)



Wiring diagram, with symbols numbered and lettered to correspond with photograph

What Would You Do in an Emergency?

New Scientific Tests for Motorists



The author in his laboratory, tabulating emotional tests of drivers

By Fred A. Moss
Assistant Professor, George Washington University

IMAGINE yourself driving along a quiet country highway, serenely enjoying the beauties of nature, when suddenly from a shaded side lane a runaway horse dashes madly into the path of your speeding machine.

Will you have the presence of mind to put on the brakes and pull over to one side to avoid a crash, or will you be frozen to inaction for the brief second that will be your time margin of safety, and apply the brakes too late? If your wife is driving, will she scream and put her hands to her face, or will she do the right thing? How correctly will you or she act under the stress of unexpected circumstances?

To determine this accurately, we conducted scientific psychological tests recently at George Washington University. These tests showed that, generally speaking, a man is a better driver than a woman, and that a young person usually is more efficient than his elders.

These conclusions were reached by means of a new device for testing human emotional reactions under emergency conditions similar to those actually encountered on the road. They were developed to discover a means of increasing traffic safety for both pedestrian and driver by cutting down the number of incompetent drivers who have the law's sanction to operate automobiles.

I recently examined a 19-year-old youth who was a driver of a five-ton truck. I found he had the mentality of a seven-year-old and could not recall the name of the firm he was working for! He simply knew he could find his way to the place whenever he tried. Yet this boy had a license to pilot a five-ton engine of death through the streets of Washington!

IN OUR experiments we found that there were four sets of tests that an applicant should meet before receiving a card entitling him to drive a car.

The first should be physical, to determine that the applicant has normal arms, legs, feet, and at least one good eye. Vision should be carefully tested as to keenness and color perception. Further eyesight tests should be made for side vision to indicate the clearness and range of applicant's view to right and left.

The second should deal with hearing. For a deaf person to drive a car efficiently is out of the question. A driver must be able to hear the approach of fire apparatus in abundant time to enable him to get out of the way. He must also be able to hear the whistle of traffic policemen.

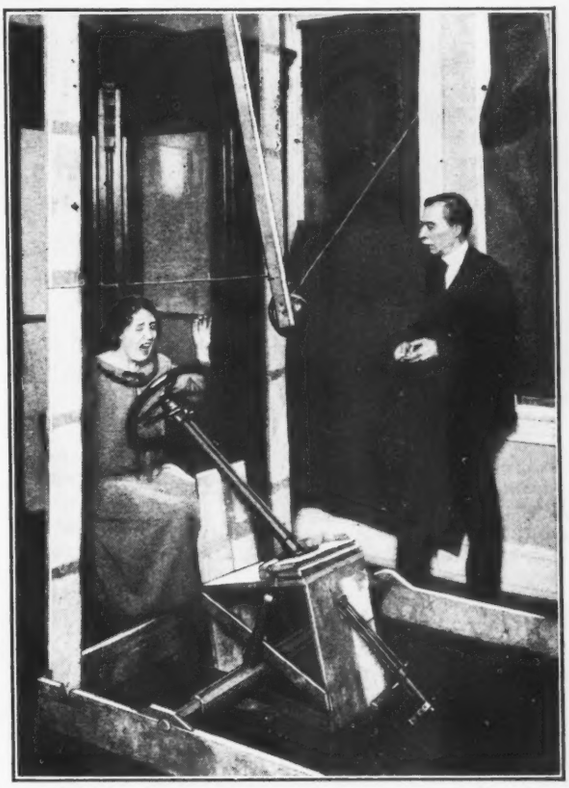
GENERAL intelligence tests should come next. There should be several forms of tests that should be varied continually so that the applicants may not be coached by some one who already has taken them.

The fourth test, one that so far has been neglected entirely, is that of emotional efficiency. To find this out we developed a machine that places the applicant face to face with some of the unexpected happenings of traffic. An individual test at this machine, in a minute and a half or less, will show just what mental reactions occur under emergency, and indicate the relative strength of the intelligence and the emotions.

This machine has for its central feature an ordinary auto steering wheel, rigged up to reproduce the actual guiding of a car. The turning of the wheel is indicated by a pointer that reproduces the changes in direction. The roadway ahead is indicated by two red lights, each light indicating an edge of the roadway. A white light between them indicates the exact center, which the driver is supposed to follow.

These three lights are fixed in a frame that is moved to right or left by the men in charge of the test, the movements representing "curves" in the imaginary "road." The driver follows the "curves" by keeping the pointer directed at the white light, and since he cannot foresee the shifts of the "road," he must pay close attention. The promptness of his response and his success in keeping the pointer on the white light denotes his alertness. This is the first part of the test.

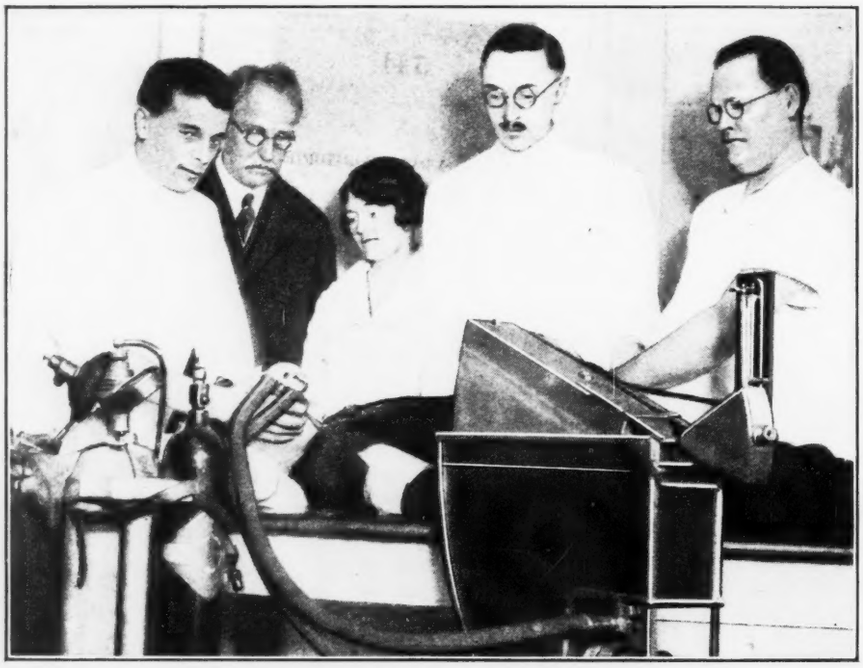
Next, an emergency is prearranged to come suddenly and without other warning than the statement, at the beginning of the test, that "during the examination something is going to happen to call for sudden action." This emergency is furnished by a headlight, thrown toward the "driver" by the release of a trigger. The headlight swings down toward his eyes from above in an arc representing 90 degrees of a circle. As it approaches on the level of the subject's eyes, this headlight simulates a car shooting out from a side street or alley.



The ingenious machine used to test a driver's reactions in an emergency. In front of the driver is a series of shifting lights indicating the roadway. The emergency is created by flashing a headlight in the driver's face in such a way as to simulate the light of another car emerging suddenly from a side road. In the test shown above the driver threw up her hands, "ditching the car," thus disqualifying herself

THE test consists of the "driver's" reaction to the approaching "car." Jamming a "foot brake" stops the flight of the lamp, or the approach of the "car," at any angle between 1 and 90 degrees, depending on the speed with which the brake is applied. The promptness with which the "brake" is used measures the speed of the subject's reaction and his level-headedness in an emergency.

This measurement is in degrees on a scale that runs from one to 90. Some drivers stop the light at from 50 to 60 degrees. Others stop more slowly. Still others release the wheel and throw up both arms. When a person does that, even though he has passed all other tests satisfactorily, we know *at once* that he is totally *unfit* to drive a car. We have a reliable measurement of his emotional efficiency, and the likelihood of his failure to meet an emergency.



This apparatus, which tests the basal metabolism of the human body—that is, the amount of oxygen consumed and the amount of carbon dioxide given off — has been employed recently to determine whether an automobile driver is intoxicated. When a person is drunk, the chemical action incidental to breathing is increased and consequently the amount of carbon dioxide given off is greater than that from a normal person

TO THROW up the arms in such circumstances means either ditching the car or a collision. Out of 105 subjects, three or four have thus "ditched the car" and two have actually given up attempting to drive as a result of this revelation of their unfitness.

These tests of the individual's behavior under carefully arranged experimental conditions show that a man in an emergency is much more likely to keep cool than a woman. This inborn tendency is due to man's greater physical strength and his greater familiarity with machinery.

A woman, on the other hand, is naturally more emotional than a man. A "close call" in a car, which necessitates extremely quick action on the driver's part, often completely unnerves a woman for the rest of the trip, or causes her to faint.

SIMILARLY such a scare will make many women "afraid to drive any farther," a tangible and highly important consideration, for fear leads to terror, and terror to paralysis. It is not an uncommon thing for a person to become so frightened that he or she cannot speak nor make a movement. This is the paralysis of fear.

Our emotional efficiency device was designed and built by Edgar Graham, an experienced aviator. Mr. Graham places drivers in four classifications: (1) The person who is safe under all conditions. (2) The one whose reactions are correct but slow, although capable of being speeded up by training. (3) The one who is all right except in congested traffic. (4) The one who, on account of mental or physical disabilities never should be allowed to drive at all.

The person in the first class is the ideal driver. The second class includes the man who has the makings of a good driver, but who must train himself into safe driving through prolonged practice. The driver in the third class should be restricted to the free zones or open country. Persons in the fourth class should not receive a license at all. In the last classification, feeble-minded drivers constitute a grave menace. I believe that the feeble-minded represent the largest class of those who have licenses to which they are not entitled.

The most dangerous defect encountered in examinations is that of slow mental response. A short time ago on one of the busy streets of the city of Washington, a woman driving a small sedan was moving forward about 15 miles an hour. As she approached a crossing, a woman stepped suddenly into the path of the car. Neither woman made an effort to prevent an accident. The car kept on and the woman on the street was killed. A prompt turn of the wheel, or a quick jump to one side would have prevented the tragedy. This is a typical instance of slow mental response. Both women were frozen into inaction by the emotional stress of impending disaster.

The perimeter test to determine a driver's ability to distinguish colored lights to the right or left. The average subject, says Mr. Moss, sees the light at about a right angle from the forward line of vision, but does not distinguish colors until the light is well toward the front. Blue and yellow are seen first

Motor traffic problems have reached such an acute stage that they demand new and advanced methods of tests for sight and hearing, which are important attributes in emotional efficiency. Periphery vision, or the ability to see to the right or left, is of the utmost importance in driving a car. The safe driver must be thoroughly aware of what is approaching from the side. He also must be able to recognize colors of signals in his side vision.

TO TEST this we devised a special perimeter. This instrument is roughly described as a band of steel curved into a half circle attached to a frame in its center and marked off in degrees from one to 90 on each side. It is held before the eyes, after the fashion of a stereopticon. A colored light slides along the arc from extreme left or right. The average subject sees the light at about a right angle from his forward line of vision, but he does not distinguish colors until the light is well toward the front. Most people cannot distinguish colors until the lights are within from 18 to 25 degrees of the center or forward point.

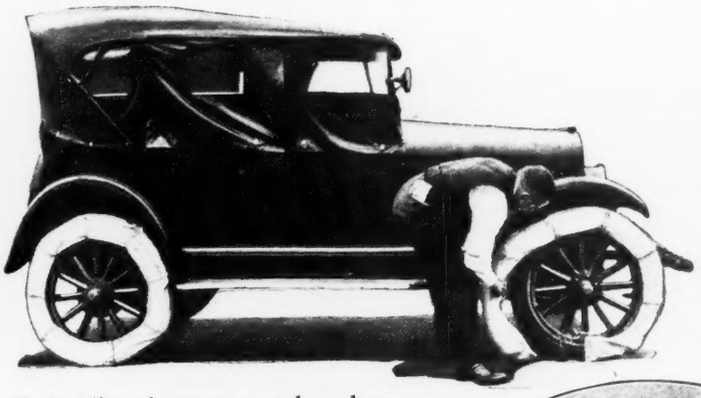
Our tests disclosed the important fact that blue and yellow are recognized several degrees before red and green, which would indicate that blue and yellow are the most practical signal lights rather than the red and green now used.

PUBLIC safety demands greater care in granting licenses to drivers. We have been working out means to attain better selection between the fit and the unfit, and to render practical aid to the authorities in making this selection. To further this work we are planning still another machine in which miniature cars will approach at various speeds.

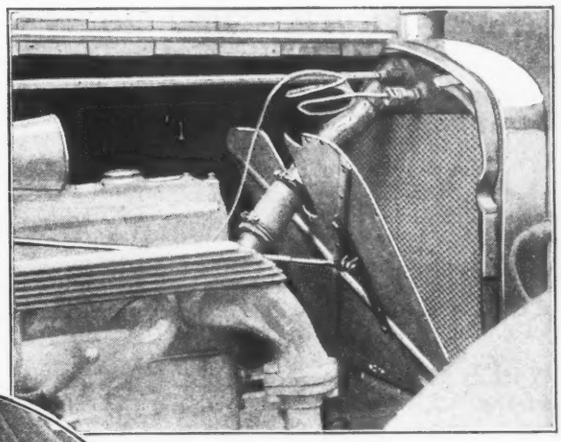
The subject being tested must judge the speed of the cars approaching at right angles in order to determine which car should cross first. Through a series of wires and levers he can control the speed of his own "car," and if he judges correctly, he can safely pilot his machine through the heavy traffic.

This test should prove of considerable value in determining the individual's speed of reaction and his eye-hand coordination. It would measure also the all-important "emotional efficiency"

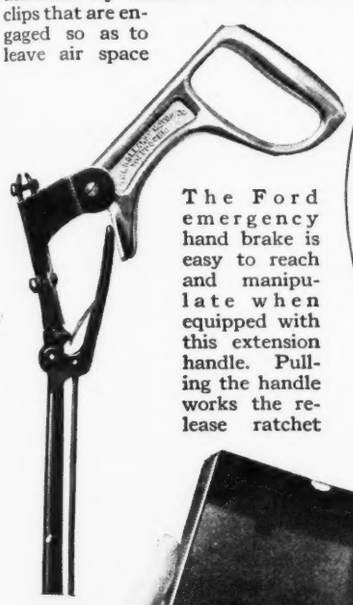
What Does Your Car Need?



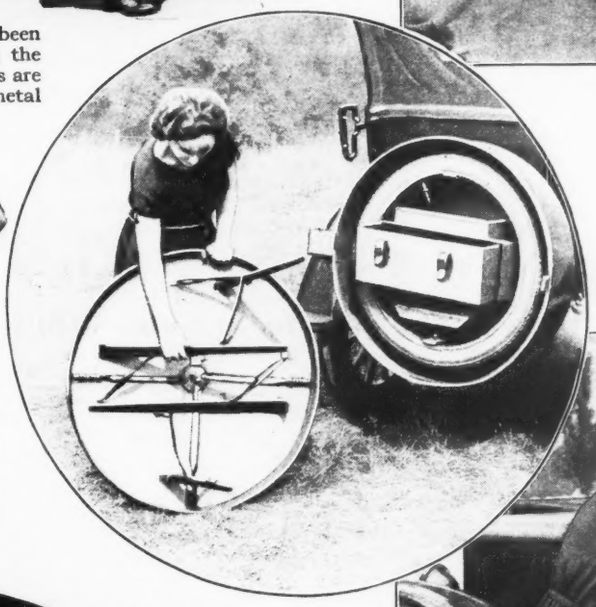
Easily adjusted canvas covers have been devised to protect auto tires from the heat of the summer sun. The covers are attached by means of resilient metal clips that are engaged so as to leave air space



A new radiator shutter that can be opened or closed by adjusting a rod extending to the dashboard of the car consists of an aluminum plate reinforced by two cross strips. The plate is attached to the back of the radiator frame on the inside of the hood by two hinges at bottom

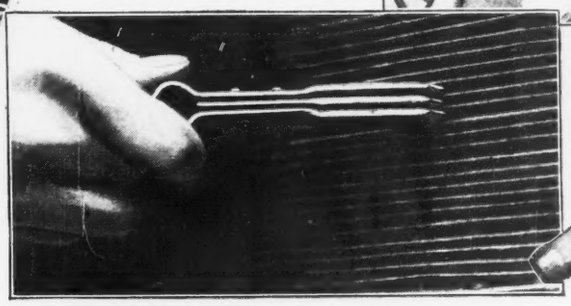


The Ford emergency hand brake is easy to reach and manipulate when equipped with this extension handle. Pulling the handle works the release ratchet

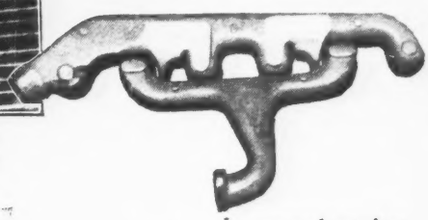


This combined tire and toolcase, camp table, and lunch kit is designed especially for the motor-camper. The tire hangs on a rack inside the watertight metal container

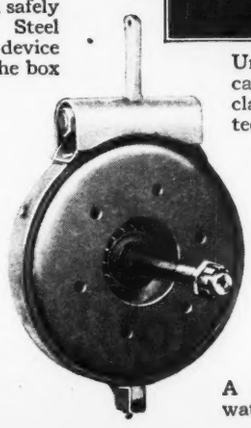
Spare electric-light bulbs for the car are carried safely in this metal box. Steel springs and a locking device hold them safely in the box



A portable refrigerator that can be attached to the runningboard, has a center container that will hold 12 pounds of ice, a large food compartment, and a special rack for bottles, jars, and cans



Unsightly bent fins at the front of the radiator can be straightened easily and quickly, it is claimed, by inserting the three teeth of this simple tool, and bending the damaged fins



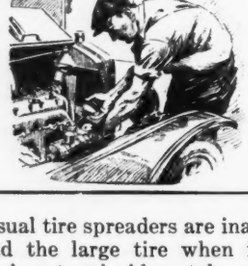
At the right is an outside view of a new front-wheel brake for Ford cars, with wheel removed. These brakes, installed in less than two hours, are said to reduce by about 30 per cent the distances required for stopping

A small lamp on this storage-battery filler lights when the water level reaches a correct height. Pressure shuts off the flow

Increased engine speed and power are said to follow installation of these twin copper conductors set in between the engine block and manifold. With the first exhaust the copper heats almost instantly, and in turn heats the fuel

Solving Balloon-Tire Problems

Time and Money-Saving Ideas for the Motorist



A FLAT tire is disagreeable at any time, but a flat balloon tire certainly is worse. One driver may have the endurance to put air into the normal tire, but in pumping up a balloon tire he will have to exert himself to the utmost. The job can be robbed of much of its disagreeable element by the use of the arrangement shown in Fig. 1. Two pumps are required as well as a standard pipe-tee connection and three short lengths of pipe for the three hose ends. Usually ⅛-in. brass pipe and connections will fit the hose used on the pump. Two persons operating these pumping units in unison just about accomplish the inflation process in the time required for the inflation of an ordinary tire by one man.

PREPARATORY to soldering, damaged auto radiators of the honeycomb type may be cleaned with a wire brush (Fig. 2) such as is used for .22 caliber rifle bores. The brush is placed in the chuck of an electric drill and for work on exceptionally thick cores a portion of the ramrod may be brazed to the brush. The device will be found useful for many other purposes.

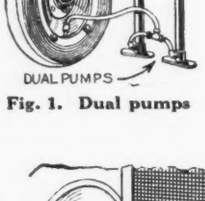


Fig. 1. Dual pumps

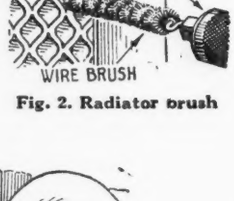


Fig. 2. Radiator brush

THE replacement of recessed bolts is often a difficult task with the use of ordinary tools. Much time and patience can be saved by utilizing the two tools shown in Fig. 3. The first of these is for turning a cap screw with a slotted head. It is a holder and driver made of a length of flat or strip steel doubled over, with the ends filed to form blades. The inherent spring of the steel grips the screw slot so that the screw can be set directly into the tapped hole and turned into place. For a hexagonal bolt, the holder tool shown is almost identical in shape, but instead of springing open, the ends are closed with a cross bolt.

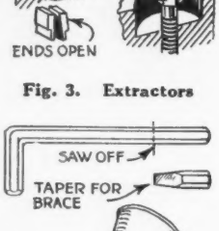


Fig. 3. Extractors

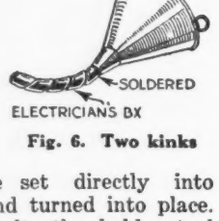


Fig. 6. Two kinks

A PUNCTURED balloon tire is rather difficult to handle with the ordinary tools employed for a tire of normal size. Two methods of removal and replacement of balloon tires are shown in Fig. 4. Since a deflated balloon tire drops the axle lower than a deflated normal tire, it is more difficult to place the jack under the axle so as to raise it the proper height above the ground. A simple ramp constructed as shown, 4 ft. long and 8 in. high at the upper end, raises the axle until it is level. The jack then can be put underneath and the tire removed.

The usual tire spreaders are inadequate to spread the large tire when it is required to insert an inside patch or roughen and cement the inside surface. Two double holders of wood, made as shown, are of assistance in holding the beads wide apart while accomplishing inside repairs. The long end serves as a handle for insertion, the tool being placed into the space between the beads and then twisted about to pry open the sides.

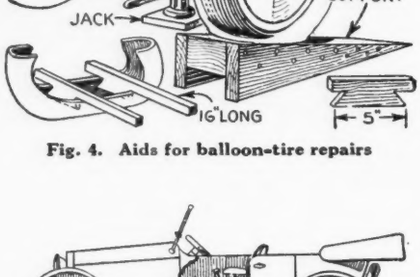


Fig. 4. Aids for balloon-tire repairs

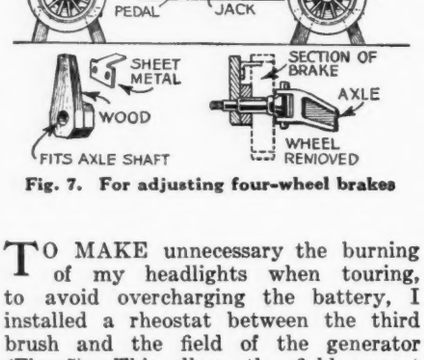


Fig. 7. For adjusting four-wheel brakes

TO MAKE unnecessary the burning of my headlights when touring, to avoid overcharging the battery, I installed a rheostat between the third brush and the field of the generator (Fig. 5). This allows the field current to be regulated. The rheostat is similar to the ones used in radio work, except that it has heavier wires to withstand the field current, which is about 4 amperes.

When driving in the city or in heavy traffic the resistance is all cut out so that the generator gives enough current for the frequent stops and starts. When the car is used in touring, the resistance is put on so that the generator gives about 5 amperes. This applies when the battery is in charged condition; if it is run down, a maximum charge can be given by cutting out the rheostat completely. —R. W. KEITH, San José, Costa Rica.

QUITE frequently an autoist has to use a funnel with a flexible tube. This is not always available and a substitute can be made, as in Fig. 6. A section of BX electrician's conduit is soldered to the spout of an ordinary funnel.

When a socket for use in a brace is needed and an adapter cannot be found or purchased, a substitute can be made as shown in Fig. 6. Take an ordinary hexagonal wrench handle and cut an inch off the handle end. File and grind one end of the short piece slightly tapered so that it fits the brace; the other end will fit the recess in the regular socket. The original handle is not damaged because it is slightly shorter. It has been found that either a square, hexagonal, or octagonal handle will serve this purpose.

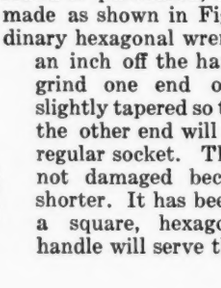


Fig. 5. Generator

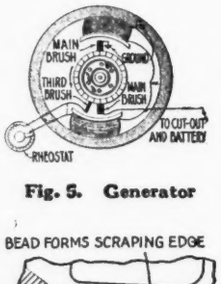
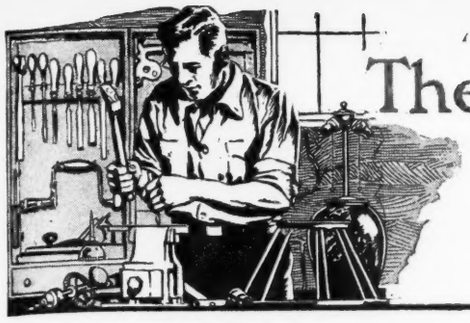


Fig. 8. Mud scraper

THE extent of the braking action on cars with four-wheel brakes is dependent upon the adjustment of all four brakes. Some form of feeler is useful for determining if the requisite clearance exists at all points around the brake drum. As it is not always possible to use a blade feeler, a serviceable tool to test concentricity at all points can be made of wood and sheet metal, as shown in Fig. 7. A gage, which fits over the axle, has a testing edge that can be moved about the entire circumference. Having made the band concentric with the axle, it is then possible to adjust the brake so that it will clear the drum at all points.

To facilitate the adjustment, the usual procedure of depressing the brake pedal with the wheels off the floor is advisable. Obviously, the front and rear wheels should be jointly jacked up, for which purpose small but substantial wooden trestles under the axles are serviceable. To hold the pedal depressed, a block or a block and jack are wedged against the pedal as illustrated.

A MUD scraper easily fitted on certain light cars that have metal runningboards may be made by cutting away for a length of about 6 in. inside the bead or rim at the edge of the runningboard to form a groove ¾ in. wide (Fig. 8).



The Home Workshop

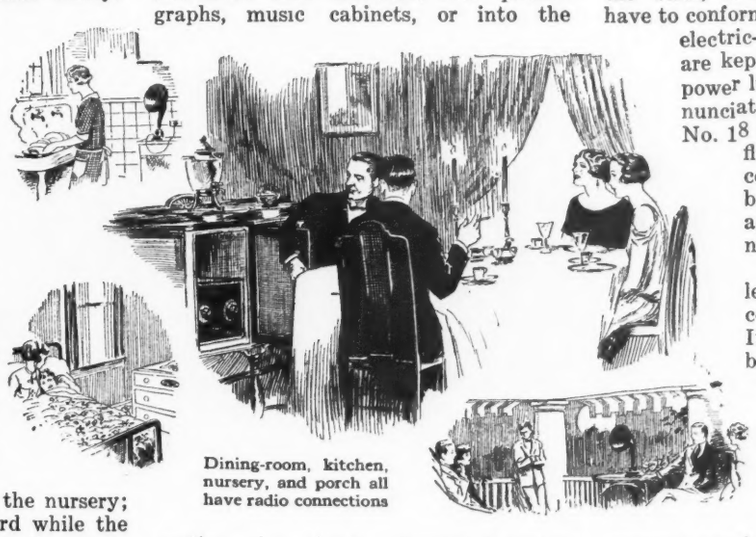
Arthur Wakeling, Editor

Building Radio into Your Home

By Kenneth M. Swezey

MORE and more, radio is emerging from its purely mechanical chrysalis and is being transformed into a gratifying and beautiful utility. This transformation is being accomplished by the provision of artistic cabinets, by the construction of sets to fit into articles of furniture, and by the use of concealed wiring with numerous outlets throughout the house so that a loudspeaker may be plugged in wherever desired.

With the coming of built-in radio, a receiving set can be incorporated in a phonograph located in the living-room. Wires branch out from this, and, by means of convenient outlets, the housewife may enjoy a concert while working in the kitchen; the kiddies can listen to a bedtime story in the nursery; delightful music can be heard while the family spends a cool evening on the porch, and an orchestra may brighten an hour at the dinner-table.



Dining-room, kitchen, nursery, and porch all have radio connections

THE wiring of a house for radio is not as difficult a feat as might be considered at first thought. For the benefit of those who would like to install a thoroughly foolproof system without first going through disappointing experiments, the following instructions have been prepared.

The amount of wiring needed in the average home of six, seven or eight rooms, does not introduce any difficult circuit problems. But in an extremely large house special apparatus would be necessary to balance the various lines, overcome the resistance, and clear out distortion.

Stretches of wire in the loudspeaker circuit seem to have little effect on the quality and volume of reception, even up to 60- and 70-ft. lengths—especially in conjunction with regenerative sets. This may be explained by the fact that regeneration nullifies ordinary resistance to a certain extent, and, due to the condenser effect of the parallel wires, the radio-frequency waves can pass between them and continue in circulation through the set with little hindrance.

The receiving set may be permanently located in any room where it is most convenient. Many choose the living-room, and have their sets built into phonographs, music cabinets, or into the section of a closet. Several ingenious mechanics even have built sets into pianos.

The first outlet is made at, or near, the set (Fig. 1), and wiring extends from that to the place where the next outlet is to be installed.

If the house is new and not complete, the wiring may be built right in the walls. Finished houses may have the wires "fished" through the walls, as an electrician fishes lighting wires. But most home workers would prefer a simpler method, and they may run their wires in inconspicuous places, such as along the edge of the baseboard, behind moldings and panels, or under the edge of the carpet, rugs, or linoleum.

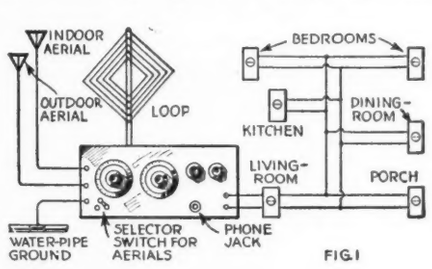


FIG. 1

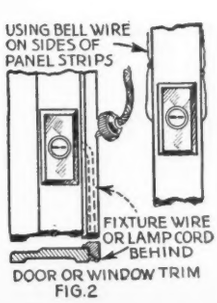


FIG. 2

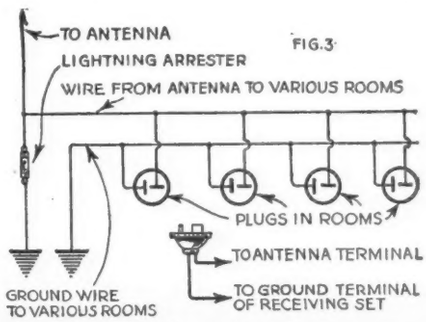


FIG. 3

How connections are made to various loudspeaker outlets (Figs. 1 and 2), and wiring scheme when a portable set with a built-in loudspeaker is used

Dangerous currents are not carried by the wires, and, therefore, they do not have to conform to the same standards as electric-light wiring, provided they are kept away from all light and power lines. Ordinary bell or annunciator wire will do, although No. 18 fixture wire, which is very flexible, or twisted lamp cord is easier to handle, better insulated, and more apt to insure the permanence of the installation.

The woodwork of a room lends itself readily to the concealment of the wires. In most instances the baseboard, door stops, and other members of the trim of the room can be pried up sufficiently to poke the wires under. This may be done with a screwdriver or a chisel, padded with cloth to prevent marring the finish. A few blows with a similarly padded hammer usually will fasten the woodwork back in its original place. Suggestions for this wiring are given in Fig. 2.

FOR outlets, the improved shallow single-circuit jacks, mounted in the center of a rectangular brass plate similar to those used with lighting outlets, are ideal. Binding-posts, mounted on small wood, fiber or composition blocks, also will serve, but they are not so convenient.

Ordinary electrical appliance outlets are excellent and reasonable in price. The loudspeaker must be supplied with a corresponding plug and all outlets have to be identical. But here care must be used that all radio outlets are marked with some unmistakable sign, lest a loud-speaker be plugged into an electrical socket by mistake, with disastrous results.

One way to accomplish this is to use polarity plugs, if the regular house plugs are of the common kind, or vice versa. Another use of polarity is indicated in Fig. 3, where a

(*Continued on page 92*)

Constructing Kites that Look like Planes

By Charles M. Miller

FOR many men, kite-flying never loses its fascination, and among boys it is a universal sport. For that reason, POPULAR SCIENCE MONTHLY asked Mr. Miller, the foremost kite authority in the United States, to prepare two articles on his latest kite designs. This is the second article, the first having been published last month.

AIRPLANE kites can be made in two ways. A plain kite similar to the tailless can have the outline of an airplane, as in Fig. 1, or one may be constructed along the lines of a real plane. The model illustrated in the accompanying photographs is a biplane. A monoplane is simple in comparison, but is not used much these days.

The framework of the plain kite consists of a spine and four cross sticks of the dimensions shown at *A*, Fig. 1. Strings are run from the end of the first to the end of the fourth stick on each side. These strings should be the same length and drawn fairly tight; they determine the length of the second and third cross sticks. The ends of the second and third sticks should be secured with the side strings. The cross sticks must be parallel. Strong thin wrapping paper is good for covering the two planes.

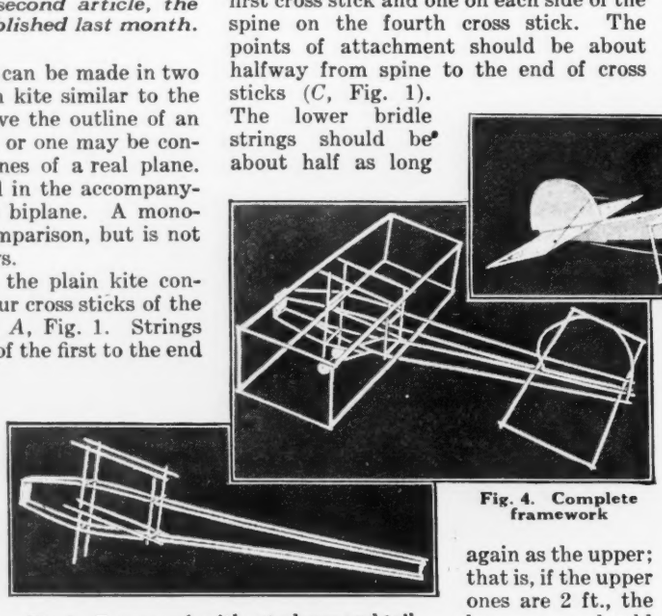


Fig. 3. Framework without planes and tail

Fig. 4. Complete framework

A keel can be added to the under side to give poise. This requires two sticks, a short one at the rear end, projecting straight out from the spine, and a long stick that forms the outer edge of the keel (*B* and *C*, Fig. 1). The keel is covered with paper on both sides. The post or back stick on this model may be about 9 in., and the outer end should have guy wires running to both ends of the fourth cross stick.

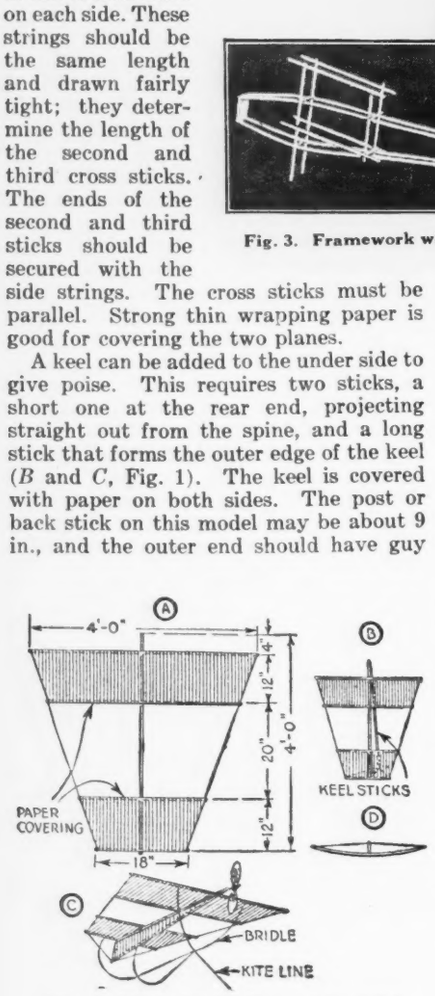


Fig. 1. A kite of the tailless variety, which resembles an airplane when flown high

The frame must be light. The spine, the heaviest stick, is about 5/16 in. thick and ½ in. wide, while the cross pieces should not exceed ¼ by ⅜ in. The keel stick need not be more than ¼ in. square. An upward bend to the ends of the planes (*D*) helps to give stability. This can be accomplished by bending each cross stick like the bow of a tailless kite.

The bridle should be attached at four points, one on each side of the spine on the first cross stick and one on each side of the spine on the fourth cross stick. The points of attachment should be about halfway from spine to the end of cross sticks (*C*, Fig. 1). The lower bridle strings should be about half as long again as the upper; that is, if the upper ones are 2 ft., the lower ones should be 3 ft. The kite line is attached where all four come together. The exact length or proportions cannot be fixed except by trial, but if the kite stands too straight up, and does not rise high in the air, the kite line should be raised on the bridle; if the kite goes up so as to ride too far overhead, lower the line on the bridle a little.

If the kite must have a tail—it is hoped it will not—streamers should be used instead of the ordinary old style tail of string and rolled up papers.

Is it understood that the covering for the planes are put on the under side of all kites? In the present case the cover will be on the same side as the keel. A paper windmill can be attached to the front end of the spine to represent the propeller.

A GREATER but far more interesting problem is the making of a kite in the form of a model airplane. The framework of the fuselage, which is the central body of the airplane, is made up of four spruce sticks 3/16 by 3/16 by 48 in.; two front uprights ¼ by ¼ by 14 in. and two rear uprights ¼ by ¼ by 8 or 9 in. (*E* and *F*, Fig. 2).

The strain on the framework should be shifted from the fuselage to the plane frames, where the lifting power is centered; the fuselage frame then becomes a mere form for effect and practically is suspended from the planes. This being the case, the framework of the fuselage can be very light. A little bracing will prevent a collapse.

The first uprights, which support the upper plane, extend 4½ in. above the fuselage frame; the second pair extend 3¼ in. above. This gives a tilt to the planes. The fuselage frame is 5½ in. high at the first pair of posts, while at the second pair it is only 4½ in. The two side frames of the fuselage are made first and then are connected by means of cross pieces 5½ in. long (*F*). The plane frames, being wider than the distance between the first and second pairs of upright posts, must necessarily overhang the space inclosed by the posts. Four pieces running from front to back support the plane frames; these are ¼ by ¼ by 12 in.

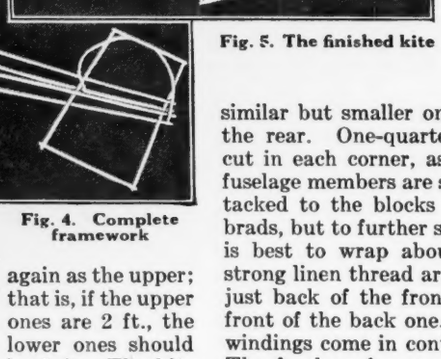


Fig. 5. The finished kite

After the sticks are securely lashed together, they should receive a good coat of shellac at the joints. Now two pieces (*G*, Fig. 2) should be made of ¼-in. pine, the one for the front end 3½ in. square, and a similar but smaller one, 2 in. square, for the rear. One-quarter-inch notches are cut in each corner, as shown. The long fuselage members are sprung together and tacked to the blocks with ½-in. No. 20 brads, but to further secure the corners, it is best to wrap about five windings of strong linen thread around all four sticks, just back of the front block and just in front of the back one. Shellac where the windings come in contact with the sticks. The fuselage framework now should be complete, as shown in Fig. 3.

The frames for each plane consist of two pieces ¼ by ½ by 48 in., and two cross pieces ¼ by ¼ by 12 in. The cross pieces extend ¼ in. beyond the long pieces so as to leave room for good lashing; in like manner the ends of the long pieces extend beyond the cross pieces. To give support between planes, short posts ¼ by ¼ by 7 in., four in number, are placed, one at each corner. The posts can be a little long and be lashed to the side, or they may stand in between, held in place by a No. 20 brad. The brad may pull out, so a piece of linen thread or fine wire should be wound about the two vertical corners, to prevent spreading.

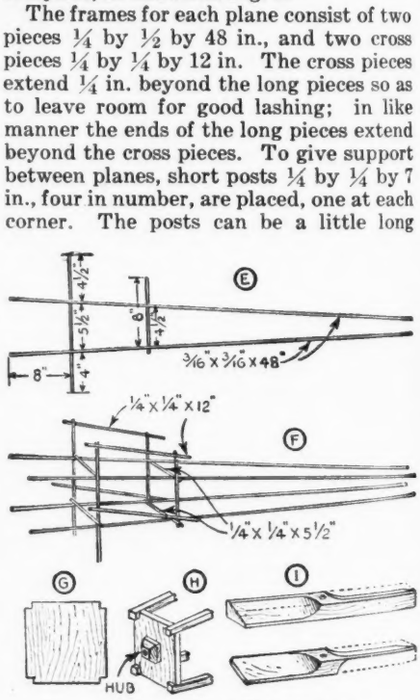


Fig. 2. First steps in building a model airplane kite, and propeller and hub details

Before the four upright posts at the corners are put in, the upper plane should

(*Continued on page 109*)

Dilapidated Table Becomes Fine Chest

By Gladstone Califf
Superintendent of Schools, Richland, Ia.

THE chest illustrated was made from the boards of a discarded walnut dining-room table and lined with cedar. To make one like it, lay out and make the sides and ends of the dimensions shown in the accompanying drawing. It is necessary that they should be perfectly square or the box will not be square when assembled. The bottom, which is cypress, is fitted in from underneath. The top can be walnut, although if it is to be upholstered, a soft wood will serve the purpose.

The sides and ends are joined with plain butt joints, glued and nailed with finishing nails. A large steel square is used for testing the squareness of the assembly.

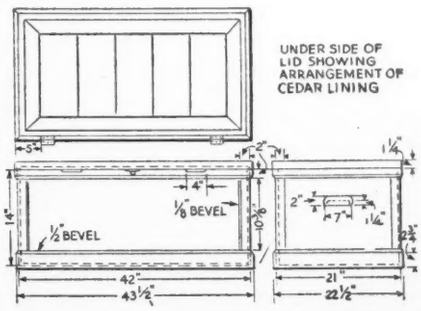
The top and bottom trim is mitered around the chest after one edge of each is planed to a ½-in. bevel. The lid trim is not beveled. All these trimming pieces are nailed and glued.

The corner protectors are mitered to fit and the outer edge of each has a ⅛-in. bevel. The mitered edges are made with a plane and tested with a T-bevel. The chest is then lined with ¼-in. thick red cedar.

In upholstering the top, the first covering of cloth is tacked at one end and a short distance along each side. The padding of flax straw or other filling then is pushed under with a short blunt stick. The padding should be level on top and sloping at the side and ends. After this part is filled, tack farther on each side and put in more padding, continuing until finished. The end is stretched tight and tacked.

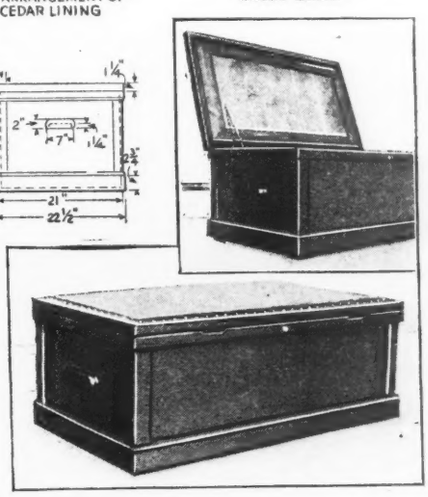
The top covering of leather or imitation leather next is tacked around sufficiently to hold it in place until the gimp or tape is fastened on with furniture nails or upholsterer's or gimp tacks. The nails or tacks should be spaced regularly and evenly all the way around.

The wood should be scraped to remove all plane marks and sandpapered smooth. If a natural finish is desired, fill the wood with natural paste filler, apply two or three coats of white shellac, rub smooth and finish with wax. The wood may be varnished if preferred.



Front and end views of the chest and under side of lid, with dimensions, are shown above. The entire chest is lined with ¼-in. red cedar and the top is upholstered

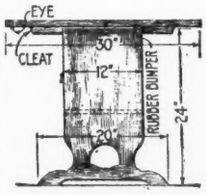
Two photographs of the chest, which has an upholstered lid, are reproduced below



Child's Bench Changes Quickly to Table

ALMOST any little girl of from four to ten years of age would be delighted to receive a combination table and chair like that illustrated. It is made of ⅞-in. pine stock glued and screwed together.

The feet are sawed from stock with the grain running lengthwise. The sides, which are made separately, are fastened to the feet with glue and with wood screws inserted from the inside. The seat is the same width as the sides, to which it is held by wooden brackets beneath and by countersunk wood screws driven in from the outside. These holes must be concealed by small wooden plugs or by putty.



The top is made by gluing up several knot-free boards and, when dry, sawing out a circle. On the under side of the top two cleats or battens are used to give additional strength to the glued joints. The cleats, which are, of course, parallel, should be fastened so as to be just outside the sides of the chair when the top is lowered.

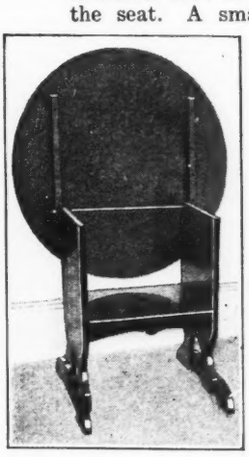
With the top in the desired position on the chair, a ⅜-in. hole is bored through each of the back corners of the sides and through the cleat. Through these holes a steel rod is run as a fulcrum on which to swing the top. The rod should be slightly longer than the distance across the cleats and must be threaded a short distance on each end for nuts to keep it in position.

If a piece of wood were fastened to the back, barn-door hinges might be substituted satisfactorily for the steel rod, although the latter gives perfect satisfaction.

A decorative piece of ⅜-in. wood is attached with finishing nails just below the seat. A small rubber-headed nail driven into the front end of each arm of the chair deadens the noise when the top is lowered.

A hook and eye should be inserted in one of the sides of the chair and in the top so that when the latter is held back, it can be hooked in place. This is to obviate any danger of the top's being knocked over accidentally on the child's head.

Before fastening the top permanently in position, the wooden parts should be given three coats of red or other colored enamel. A glossy finish is impervious to smudgy fingers.—R. L. SIMONS.



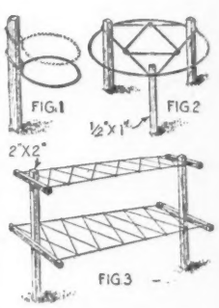
The combination bench and table and diagram, showing suitable dimensions

Supports for Growing Plants

SUITABLE supports for thin stemmed plants that grow to a height of 18 in. or more can be made of light stakes and strong but readily bendable wire.

An adjustable plant support made from a piece of wire 2 ft. long or less and a single stake is illustrated in Fig. 1. A three-stake compartment support (Fig. 2) is better for plants such as peonies, which send up frail stems with heavy foliage at the top.

A method of supporting very tall plants, such as cosmos, which generally are placed in a line or screen formation, is indicated in Fig. 3. At each end of the line a stake not less than 2 by 2 in. and 6 ft. high is driven deeply into the ground. Halfway up, a crosspiece is nailed; this should be as long as the line of plants will be wide. At the top a shorter cross piece is nailed. The cross pieces are connected by four light, straight wires.



Types of support

When the plants are well above the lower wires, either wire or cord should be crisscrossed from wire to wire, making a number of compartments, and this is repeated when the plants have grown above the upper wires. Stakes and wire should be painted or stained green or brown so that they will be relatively inconspicuous.—WILLIAM F. SANDMAN, Indianapolis, Ind.

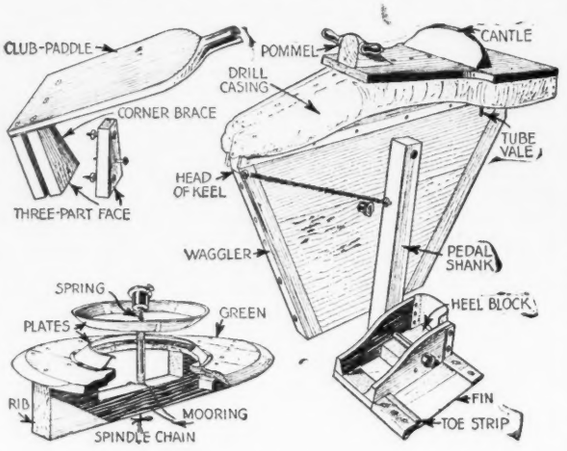
"Wagglers" for Water Golf Made at Home

By Roland B. Cutler

GAMEY, free-for-all water golf can be played with the homemade outfit illustrated. "Greens" can be moored almost anywhere, and a two-hole course can be played back and forth even on a pond.

The waggler, fitted with air tubes under the seat, can be shifted about with pedal-fins, which have power enough to propel slowly. The combined paddle and club will drive, loft, and putt either a light, 2-in. waterproofed wooden ball, a tennis ball, or a rubber ball with a spongy core, about 2½-in. size.

Above: A game of water golf in progress. At right: Details of the pedal-driven "waggler," the combination club and paddle, and one of the "holes"



The materials needed for one outfit are.

Pine board, ⅞ by 12 in. by 10 ft.
Ash paddle-board, 1 by 6 by 36 in.
Studding, 2 by 2 by 40 in.
Studding, 2 by 3 by 14 in.
2 corner braces, 3 in.
3 corner braces, 4 in.
1 bolt, ¼ by 5½ in.
2 door springs, ¼ by 16 in.
2 large furniture glides (casters)
1 yd. drilling, 30 in. wide
2 pieces galvanized sheet steel, each 4 by 14 in.
2 lengths ¼-in. gaspipe, each 7 in. long, fitted with caps
2 doz. screws, No. 6, ¾ in.; 2 doz. screws, No. 10, 1½ in.; 2 base-knobs; ½ doz. screw-eyes, 1½ in.; 1 doz. ¾-in. copper rivets and burrs; 6 nuts, ¼ in.; 2 laths; 2 discarded inner tubes, patched.

Each hole requires:

1 good barrel-head
Studding-rib, 2 by 4 by 18 in. long
¾-in. gaspipe, 7 in. long, and one nut
2 pie-plates, 10-in., heavy tin or agateware
1 coilspring, ⅜ by 5 in.
½ ft. jack-chain, ⅝-in. link; large spool; cotter-pins

Each half of the waggler's keel is cut from a 12-in. board, the upper part being 34 in. long. The seat-board is 24 in. long and 8 in. wide at the cantle. Pommel and cantle are shaped from 2 by 3's.

Slit 15 in. of the drilling to center under the board, at the rear, and tack around a back-board 3 in. wide, as indicated. Set two 4-in. corner braces to support the seat, 9 in. from the rear end of the keel board. Then assemble these parts.

Each doubled inner tube extends under the seat, to be doubled again at the rear. Tie the tubes at the head. Secure the drill casing with a lath at each side, and fold to inclose the head.

Each side of a pedal is 9 in. long and 3 in. high, with a heel-block 5 by 2½ in. wide nailed between. Over this block, locate the pipe-axle 3½ in. from the heel end. Shape the sides as shown, and attach a toe-strip ½ by 2 by 8 in. long. Set a 3-in. corner brace at the heel, and rivet the fin under the strip. Complete the heel with leather fastened securely against backward thrust.

Let the lower keel-board, when joined with side strips, be 15 in. long at the bottom. Cut a 2 by 2 in. pedal shank, 20 in. long, and locate the axle 1½ in. from an end. Set a gliding caster 8 in. from this end, to slide over the keel. Pivot the shanks to the keel 10 in. below the center of the seat. To block the shank, set a spool-knob about 15 in. below the seat. Run the shank spring as indicated.

Any thick barrel-head makes a "green" for a hole. Cleat the head to allow for a center cut-out of 8½-in. diameter, and space for the 2-by-4 rib. This rib is cut down 2 in. below the hole, with a ⅝-in. hole centered for the gaspipe spindle, which is turned in like a screw.

Cut around the bottom of a pie-plate, allowing a ¼-in. projection, and center it bottom up around the spindle. Nail down the rim. The upper plate, with a bottom hole centered for the spring extension, sets on the spindle-nut, which must be locked over jammed threads, flush, or above the pipe end. Pin one end of the spring in a large spool, as indicated, and to the other end hook jack-chain, to be pinned under the rib. Adjust the spindle to allow space between plates of about ¼ in. less than the diameter of the ball.

The club-paddle blade is about 12 in. long and ⅜ in. thick. The three club parts are alike, each ⅞-in. stock, 4 in. high, with a 2½-in. sole, and 1-in. top. Fit a 4-in. corner brace to the middle part; then attach each side with three long screws and spacing nuts. Pad between the blade and attachment with a rubber cut T shape. Keep the spindle spring well greased, and paint and oil all the equipment.

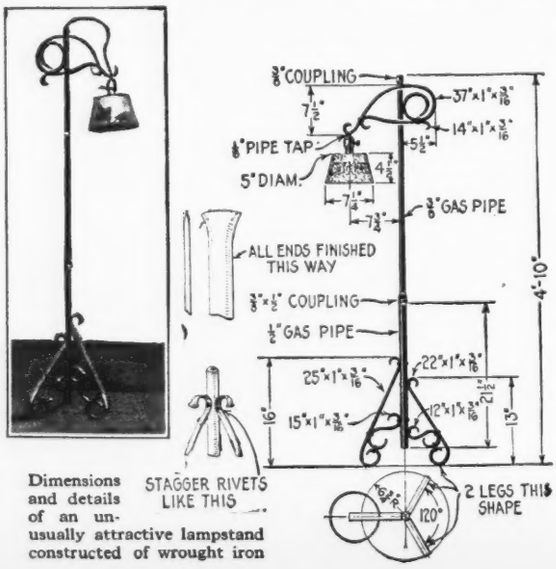
Graceful Wrought-Iron Reading-Lamp for the Amateur Craftsman

By H. T. Shrum
State Normal School, Oshkosh, Wis.

ARTISTIC wrought-iron work has been revived to a great extent during the last few years and many decorative pieces are being used in the home. This is evident from the number of iron candlesticks, plant and aquarium stands and reading lamps to be seen in the art and gift shops.

The accompanying photograph and drawing offer a suggestion that might be used as the basis for the design of a reading-lamp, or the dimensions may be followed and an exact copy of the original lamp made by any craftsman who has access to a forge.

Care must be taken to make the design well proportioned in order that the finished product may be pleasing to the eye and not too heavy in any one part. The method of joining the parts must be considered carefully. Where rivets are used—and I think that this method of fastening is the best for this type of work—there must be consideration for drilling holes, for heading the rivets, and backing up the rivet heads.



Dimensions and details of an unusually attractive lampstand constructed of wrought iron

If round-headed rivets are used, the shape of the head may be retained and the riveting done very easily by making a special tool to fit in the hardy hole of the anvil. This is merely a short piece of ¾- or ⅞-in. iron bent to a right angle to fit in the hardy hole and project an inch or two beyond the edge of the anvil, where it bears a dent the size of the rivet head.

Care also must be taken when laying out the rivet holes to have them at the points of contact or the

(*Continued on page 98*)

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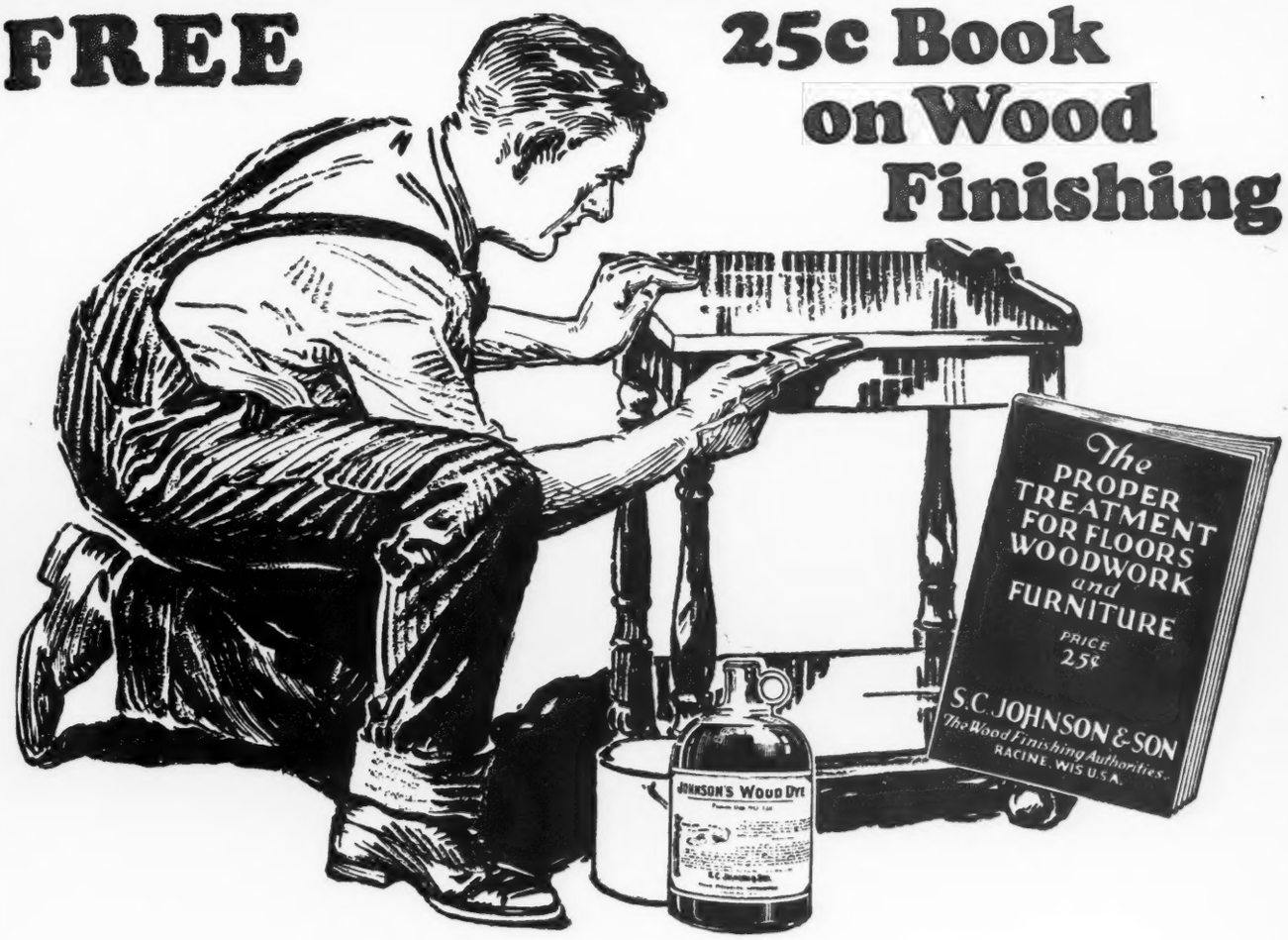
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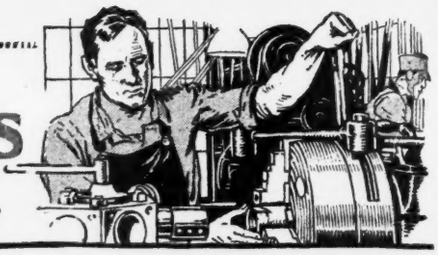
Better Shop Methods

How Expert Mechanics Save Time and Labor



How to Make the Most of Planer and Shaper

By H. L. Wheeler
Machine-Shop Foreman

"TOOLS are tools," remarked Old Bill to one of the machine hands, "and it doesn't make so much difference as you think whether they go in a lathe or planer or milling machine. Cutting metal is the same problem, no matter where you run up against it."

Old Bill, wise in machine-shop methods from many years of hard experience and shrewd observation, is a stickler for watching what he calls the business end of any machine tool—the cutting tool itself. To do its work properly, the tool must conform to certain well established principles of form, and these principles apply whenever metal is to be cut.

Shaper and planer tools are very similar to lathe tools: in fact, a tool made for one may be adapted readily to any of the three, as the cutting action of these machines is practically the same. The only actual difference is that lathe tools as a rule require a little more clearance

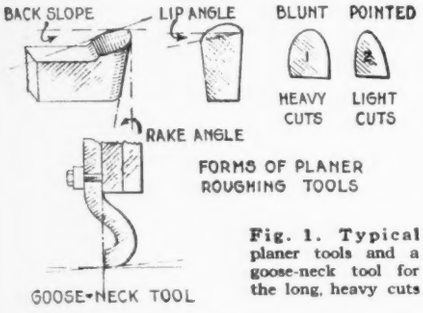


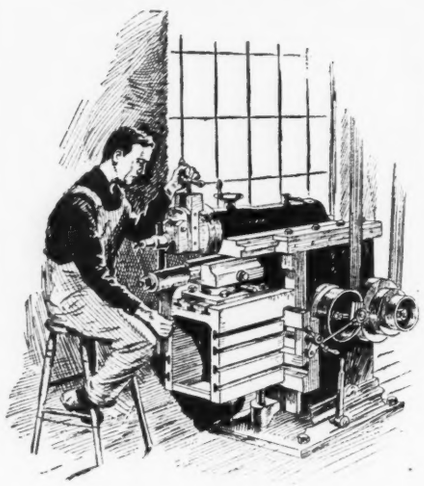
Fig. 1. Typical planer tools and a goose-neck tool for the long, heavy cuts

than planer and shaper tools. The angle for planing tools is from 3 to 4 degrees and that for lathe tools from 5 to 8 degrees (Fig. 1).

The clearance angle will vary for the different metals and the kind of cut being taken; in any case it should be only enough to allow the tools to cut freely and avoid digging into the work. Too much rake will weaken the cutting edge and give it a tendency to dig into the work.

The slope angle should be decreased as the depth of cut and the feed are increased. The reason for this is that heavy cuts induce excessive pressure on the tool, therefore it is evident that a blunt tool with a stiff cutting edge is better able to resist the increased pressure.

The goose-neck tool shown in Fig. 1 gives better results on long, heavy cuts than a straight tool. A straight planer tool has a tendency to dig into the work and chatter when there is any looseness



Using a shaper to finish a circular surface on work that will not swing on centers

in the head or rail. This is eliminated with the goose-neck, as it springs away from the work and will not cause any damage by undercutting. The cutting point of this tool should be on a line with the rear side of the shank or even farther back.

In the larger shops, machine tools seldom are expected to perform unusual tasks or do stunts. Small jobbing shops with only a few machines often are called upon to perform almost impossible jobs or jobs that are not strictly within the range of their equipment.

A few illustrations will give some idea of what may be accomplished on a small planer. In Fig. 2 is shown how a large casting was planed on a small planer. The casting could not be fastened on the platen and passed under the rail or between the housings, so it was set up on the floor alongside the machine. The cross rail was removed and set up on the front end of the platen with angle plates and blocking. This allowed it to project far enough to one side to reach over the area to be planed. When the casting was located and leveled and the cross rail fastened in the desired position, the stroke was set and the tool was fed across the work by hand.

The familiar magnetic chuck, used extensively on grinding machines, is a time-saving fixture to use on planers for holding flat parallel strips and similar work. Try planing a strip of steel or iron 3 or 4 ft. long, 2 in. wide and ⅛ in. thick by holding it in the old fashioned way; 9 pieces out of 10 will be neither straight nor parallel. Now try this same job with a magnetic chuck and note the difference in time saved in setting up and in the quality of the work. Often the time saved in setting up various jobs by the old method of bolts, straps, pins, hold downs, and the like will more than pay for one of these chucks. They are made

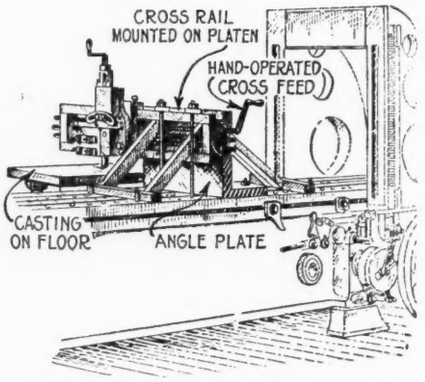


Fig. 2. Method of planing a casting too large to be handled on the machine's platen

in various lengths. For extra long work, two chucks may be used end to end. It will be much cheaper to purchase one of these chucks than to attempt to make one. In addition, with their use the planer may be converted readily into a grinder simply by mounting an emery wheel on the cross rail.

Another useful attachment for the planer is a milling head, which practically converts the planer into a milling machine. In conjunction with this a good set of indexing planer centers are valuable. These attachments may be purchased or built in the

(Continued on page 82)

Old Bill Says—

WHENEVER you feel like saying, "I don't know how," stop and think if it wouldn't be better to make it, "I'd like to try!"

Taking a couple of inches out of the belt sometimes helps to speed up a machine that is slipping or lagging on the job.

You never put on your collar before your shirt; why try to do a thing backward in your shop work?

The man who first said "Make haste slowly" must have been a machinist; if he wasn't, he ought to have been, because it certainly holds good in the shop.

Don't take it for granted that a tap will stay sharp forever. It's like any other tool, and if you grind it occasionally, you'll do better work and won't be so apt to break it.

Fancy frills on machine work went out of style ages ago, unless a customer wants to pay for them, and that's another story.

"All Starrett's!"

"Boy—you certainly come well recommended."

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Need for Studying Better Shop Methods Shown in Piston-Ring Contest

ASTONISHING in one respect were the letters submitted in POPULAR SCIENCE MONTHLY'S recent contest on the machining of special interlocking piston rings—no two of the solutions were alike. Every one of the replies varied somewhat in the method suggested for making the rings. In view of the relative simplicity of the problem, this variation was surprising.

It will be recalled that the contest, which was announced in the May issue, was for a story giving the clearest information—just as a machine-shop foreman might give it to a relatively green machine hand—as to the simplest and quickest way to make the special locked-joint piston ring illustrated in Fig. 1.

That thoroughly experienced machine-shop foremen and machinists should differ so much on the steps to be taken and the tools to be used is a striking commentary upon the necessity for careful study of shop methods and the vital need for the interchange of opinion among mechanics as in the columns of the Better Shop Methods Department.

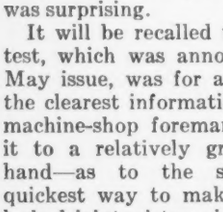


Fig. 2. Machining a step-jointed ring

The original problem was submitted by George A. Luers, one of the best known writers on mechanical and automotive subjects, and it is interesting to compare his solution with those offered by the prize-winning contestants. Mr. Luers said:

"Recently we had a small air pump under construction that involved metal packing rings. Inasmuch as it was desired to lock the rings in the cylinders because of a port, a special lock joint of the type sketched in Fig. 1 was decided upon. When the drawing reached the machine shop, the problem had to be explained thoroughly to the foreman before he would acknowledge that the design was at all reasonable.

"An ordinary step-joint piston ring is illustrated in Fig. 2. When the ring is closed, the machining is not obvious, but when the ring is expanded, it will be seen that a slot at the top and bottom severs the ring and makes the lap joint. In the special lock joint the same procedure applies. After the slots are made, the ring is milled off on the outside and end mill cuts are made on the two areas inside in the wake of the interlocking ends."

The prize-winning letters are as follows:

By Frank N. Coakley
Buffalo, N. Y.

First Prize, $10

"JIM, we have a job this morning that I should like you to take hold of and machine."

The boss had called Jim into his office early one Monday morning to talk over the production of a new style piston ring, which had been submitted for prices.

"We have a chance of receiving a good size order," he continued, "if we can handle this in a short time. The time element will govern the price. Now, here is what the ring looks like."

Fig. 1. The problem is to explain the method of machining this special interlocking piston ring

The boss copied from a blueprint a ring such as is shown in Fig. 1, 3 in. in outside diameter and 2⅝ in. inside diameter.

"You see, Jim, the scheme is to have locked joints, so they put that little projection on the inside to do the work. According to the print the lock is ¼ in. long. To make allowance for the lock you will have to turn a ring 3 3/16 in. in diameter.

"After we turn the ring up, we had better saw it apart with a hacksaw. This we will call our second operation (Fig. 3). The third operation I think we had better do on the small bench lathe, using the milling attachment. Of course, our ring will be fastened flat to the fixture. Now we will turn the ring over and make it look like this," and he drew a dotted line to show the fourth operation.

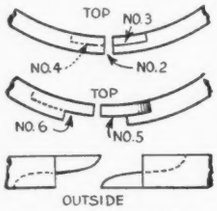


Fig. 3. Mr. Coakley's method (first prize)

"You will have to make a little rig to hold the ring, so that you can rotate it the length of the lap, so that the lines will be curved alike. Now we can go to our fifth and sixth operation, which I think we had better do on that little bench filing machine of ours. That will give us a ring looking like this from the top and something like this from the outside," and he drew the second and third sketches in Fig. 3.

"Now our ring is ready to lap together. It might be necessary, Jim, for you to smooth up the inside and outside of the ring after you get through with the last two operations. Now, let's see what we can do. Bring in a couple of rings when you finish them and if you find a shorter way to do the job, a little present will be yours. You see, the order is worth it."

By James Ellis
Memphis, Tenn.

Second Prize, $5

ED MUST have thought that I had something unusual when I approached him, for he looked at me with an air of "Why pick on me?"

But pick I did. It was a piston ring with a most peculiar joint. Something like some of the fancy rings on the market, but not quite. Only three were wanted, so we could spend no money on special fixtures; and, as they were wanted in a hurry, there was no time to lose in discussing the method to use. The ring was for a small air compressor, and the joint was made as shown at *A* (Fig. 4).

Ed looked at the blueprint and groaned.

"How in the world am I going to make that *thing?*" he asked.

"Not so hard to do, Ed," I replied. "How does this scheme strike you?

"First turn up the rings in the usual way, and leave a third of the length of the lap on the diameter to make the joint, and a little more so that you can return them after the joint is made. Finish the width to the dimension given. Then cut a slot across the face of the ring like this (*B*). You can do this on the shaper or the milling machine, whichever you like and can get.

"The next thing you will have to do on the milling machine, though. You will have to use a rather small cutter, and you can't use an end mill very well, so I would suggest that you use a Woodruff keyway cutter. Scribe a line across the diameter of the ring at right angles to the slot you have just made. This line is to help locate the ring on the milling-machine

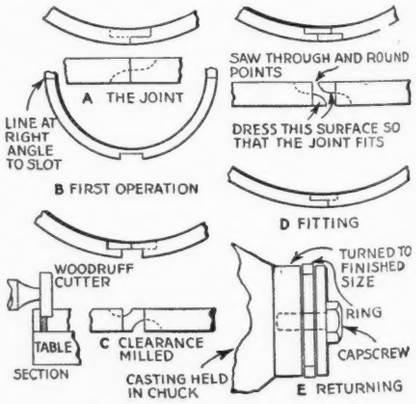


Fig. 4. Steps suggested by Mr. Ellis, winner of the second prize

table. Clamp the ring right on the table, close to the edge where you can reach it with the Woodruff cutter. Set the line just made parallel with the edge of the table. Start the cut in the slot already

(*Continued on page 79*)

Need for Studying Shop Methods

(*Continued from page 78*)

made, and cut just even with the edge of that slot. The depth should be exactly half the width of the ring. Use the micrometer dial to get the depth.

"When one side is milled, turn the ring over and do the other side in the same way. You will have to transfer your center line to the other side in order to set up for the second in correct relation with the first.

"The ring will now look like this (*C*). You might do some more milling on this ring, but I think you will do better by taking it to a vise and filing the rest of the way. Saw the ring in two in the center of the first slot, and file the points so that they will fit up into the curve left by the milling cutter.

"You will probably have to file the ends of the points in the direction of the thickness, too, for you have been making straight cuts, and the ring is a circle (*D*). This is the most particular part of the job, Ed, and I want you to be very careful, for if the man who designed this ever sees it, the first thing he will do will be to see how well that part fits.

"When you get the joint made, make a holder something like this (*E*) to re-turn the rings. Chuck a piece of cast iron large enough to true up to the finished size of the ring, and turn it back to that size. Face off the end square and drill and tap a hole for a cap screw. Find a washer, or make one, so that you can clamp the ring to the face of this casting while it is still in the lathe. The finished part, which is the same size as the ring you are going to turn, will help you to locate the ring. Turn off the diameter, and the job is done."

Ed smiled.

"That doesn't sound so hard. I'll see how hard it really is."

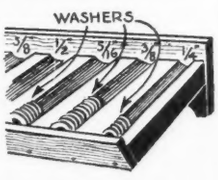
Ed made the rings.

While the solution of Mr. Ellis is open to the criticism that he has neglected the run of the milling cutter and that he might better have cut the ring and expanded it before milling the lip clearance, he has, nevertheless, covered the necessary machining methods and done it with a clearness and precision that are to be commended highly.

Other readers who are entitled to honorable mention for their contributions are:

James Oswald, Brooklyn, N. Y.
John Maghirelli, New York.

Rack Keeps Washers Sorted



WHEN you are in a hurry, it is an exasperating job to find the right washer in a boxful of assorted sizes. The wooden rack or tray illustrated enables you to pick out the proper sized washer immediately and to tell at a glance whether your stock is getting low.

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By V. K. Cassady, Chief Chemist

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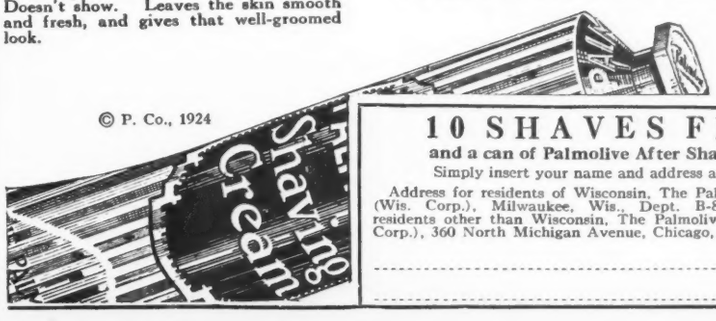

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Shop Hints that Save Time and Effort

FILING is an art in which mastery depends mainly upon practice. What a real expert can do with a file is little short of astonishing. There are, however, a few simple directions in regard to filing that no one should overlook. One of these is that a hand file should be used only as a one-way tool. The teeth are shaped to cut on the forward stroke only. Filing on the return will ruin the tool. Use a machine file and never a hand file in a filing machine, as the pressure is applied both ways.

In filing shafting or other round work in a lathe, keep oil on the work to prevent clogging and to avoid making ridges and score marks on the work. In any kind of filing keep enough pressure on the work, otherwise the surface will become glazed and the file points dull.

Remember that the more commonly used files are thickest in the middle to allow for the rocking that invariably occurs while working (Fig. 1). For this reason fewer teeth are in contact with the work than would be the case if the file were perfectly flat, and the bite of the teeth also is greater.

Using a file as a hammer or throwing it into the toolchest among other tools will soon make it worthless for fine work. It should be given the care accorded to edge tools.

Large files should never be fitted to their handles by boring a hole in the wood and forcing in the tine. The pressure will split the handle sooner or later. Bore a hole the size of the small end and then burn out the rest with the tine heated to a low red. Keep wet waste around the body of the file so as not to draw the temper.

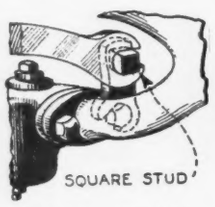


Fig. 2. Wrench for awkward work

Fig. 1 Filing

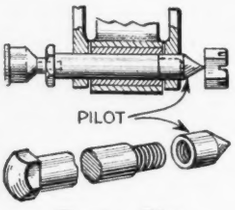


Fig. 3. Pilot for spring bolt

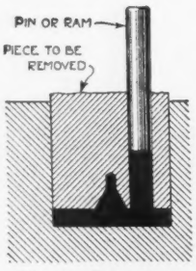


Fig. 4. Removing a stubborn stud

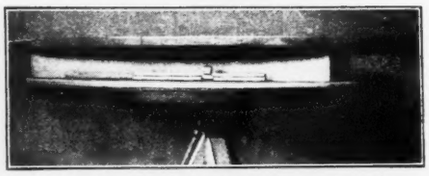


Fig. 5. An adjustable drawing-board

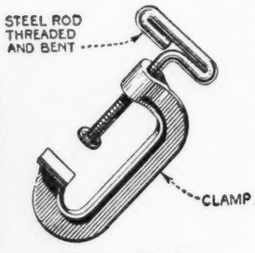


Fig. 6. Handy C clamp

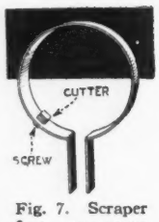


Fig. 7. Scraper for grooves

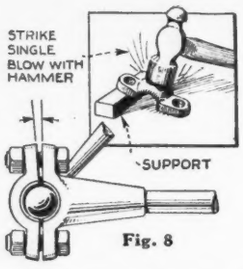


Fig. 8

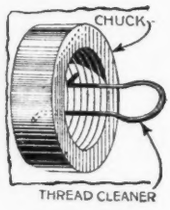


Fig. 9. Wire cleaner

CLOSE quarters in which it is almost impossible to use any of the standard wrenches for removing bolts and nuts, are often encountered. For such contingencies it is useful to have a set of special wrenches. These can be made out of the ordinary wrenches simply by cutting them down, as shown in Fig. 2, and riveting in a short square stud solid enough to withstand the pull of another wrench. A set of these will shorten repair jobs and make unnecessary the use of chisels and punches to turn inaccessible nuts.

A HANDY pilot that will aid in starting spring shackle bolts into their seats is shown in Fig. 3. Made from the end of an old bolt, it is tapped to conform to the shackle-bolt thread and is ground to a taper. The outside diameter should be the same as that of the shackle bolt. When the pilot is screwed on in place of the nut, the bolt can be driven in with ease.

STUDS or pins that defy removal by usual methods sometimes can be driven out of their seats by hydraulic pressure, as shown in Fig. 4. The piece is cut off near the surface of the piece in which it is embedded. A hole is then drilled to the bottom and reamed so that the sides are smooth and parallel. A ram is made of hard steel to fit this hole accurately, yet not so as to bind. Fill the cavity under the plug and the drill hole nearly full of heavy oil, insert the pin, and strike it with a hammer. The force of the blow will be transmitted through the oil. Thus a 100-pound blow on a ram ¼ in. in diameter will exert an upward force of 1600 pounds on a 1-in. plug.

A SWIVEL-TOP drawing-board stand (Fig. 5) was made from an old buggy wheel and its axle. The axle was cut down sufficiently to enable the table to rest on top of the hub, and then held upright by four 2 by 4 in. legs. The lower ends of these legs rest upon two cross pieces, which intersect with a cross-lap joint in the center. The axle rests upon the intersection.

The table top is built on the wheel, with its center resting on the hub. A square box, the four corners of which come flush with the tire, serve as the main support for the top, which is round and extends 2 in. beyond the tire.

TO SAVE time in the use of C clamps, a Washington, D. C., shop substitutes for the usual square-headed setscrew, a clamp screw made as shown in Fig. 6. Round bar steel stock is used. One end is bent to form a handle and the other to fit the clamp. The advantage lies in doing away with the need for a wrench to tighten the clamp.

IN REMOVING carbon from piston-ring grooves, a tool such as is shown in Fig. 7 comes in handy and saves considerable time and effort. An ordinary piston-ring compressing tool or a strip of cold rolled steel slightly wider than the groove and of sufficient stiffness is shaped to fit the piston. A piece of a file is annealed and allowed to cool slowly from a cherry red in the ashes of a fire. This is cut to fit the groove and fastened to the inside of the tool with a machine screw. When hardened, it serves well to scrape the edges of the groove.

THE play in ball-and-socket connections such as is found on the tie rod of automobile steering mechanisms can be taken up quickly by bending the cap slightly with light hammer taps. The cap is removed and one end is elevated a trifle, as shown in Fig. 8. Striking the center, a single blow will turn the flanges back so that when the cap is replaced the bolts will draw the center down on the ball. Since these parts are made of forged steel, this treatment does not injure them in any way.

INTERNAL threads of chucks sometimes hold chips, dirt and grit, even though the mechanic attempts to clean them with waste. A bent piece of spring brass wire, the ends of which are ground to fit the thread profile, as is shown in Fig. 9, will aid in the removing of this dirt.

The spring keeps the points pressed lightly in the grooves as the device is screwed through the chuck, and the points sweep the dirt and grit ahead of them.

FEATURES FOR SHOP MEN

IF YOU are interested in the problems of the machine shop, POPULAR SCIENCE MONTHLY has in store for you several articles that you will be almost certain to vote the most helpful of their kind you have read.

One of them, to be published next month, is "Getting the Most Out of Your Milling Machine." Another, which will follow in a month or two, is "Remedies for Shop Troubles in Machining." Both are by Albert A. Dowd, consulting engineer.

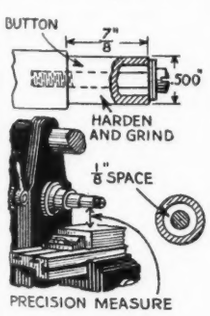
These two features in a way represent a new trend in the literature of the machine shop. They are the results of the efforts of the Editor of the Better Shop Methods Department to persuade men like Mr. Dowd, who are outstanding figures in machine tool design and production methods—men responsible in large measure for the astounding achievements of the modern machine shop—to digress temporarily from their own field of abstruse engineering problems and place their wide and incalculably valuable shop experience at the disposal of the average machinist, to help him with the everyday problems of his work.

Much noteworthy information is available on the higher branches of design and production management. A sample is Mr. Dowd's own recent monumental work, "Tool Engineering," written in collaboration with Frank W. Curtis. To publish material of such high caliber, but written from the standpoint of the average mechanic in the shop, is the object of the Better Shop Methods Department, and this coming series, in particular, will have a distinct dollars and cents value for every machinist.

Spindle Button Will Aid in Locating Work Accurately

FOR truing up work and finding the location of points precisely in the milling machine, a spindle button made as shown will be found a great convenience.

The button is a hardened steel bushing fastened to a steel shank, straight or tapered, with a machine screw and washer. The diameter of the bushing should be an even dimension to facilitate calculations. The hole is large enough to allow about ⅛ in. play around the screw.



Button for use on milling machine

The tool is inserted in the spindle or held in a drill chuck, if it has a straight shank. Tighten the screw just enough to allow the bushing to slip with some friction. Run the spindle at high speed and hold the end of a scale against the bushing until it revolves perfectly true; then tighten the screw.

The button now forms an accurate center from which measurements may be taken in any direction with the height gage, verniers, micrometers, or with the feed screws of the machine.

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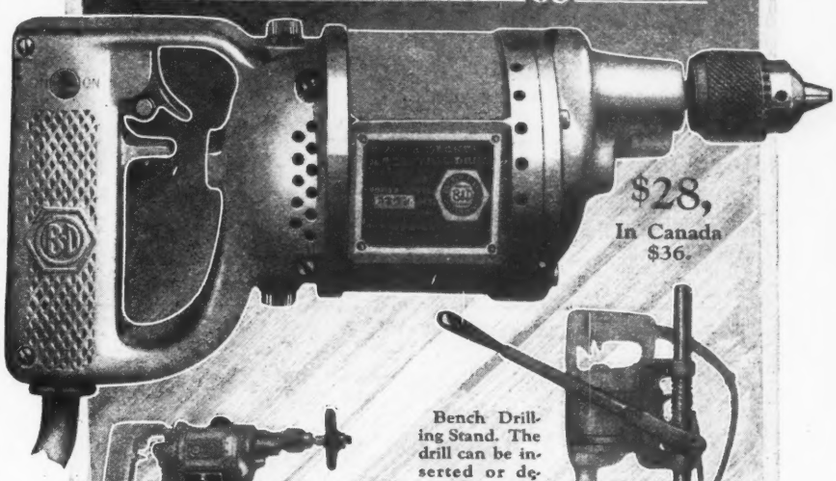

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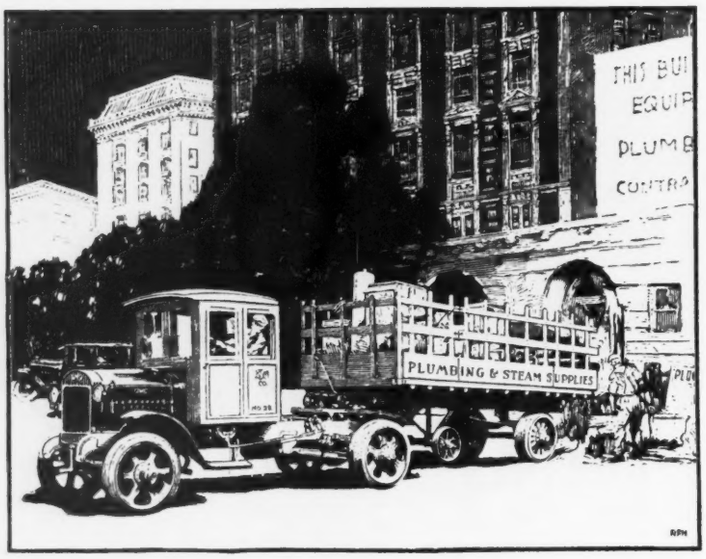

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How to Make the Most of Planer and Shaper

(*Continued from page 76*)

shop. In either case they will prove to be a profitable investment for the small shop where more expensive equipment cannot be afforded.

Planing tapers, curves, irregular surfaces, cam faces and the like is accomplished by means of specially designed fixtures. The expense of such fixtures is warranted only by the prospect of sufficient work for the time and trouble of building them or when the customer is willing to pay for them. A typical example of this class of work is shown in Fig. 3.

One very important consideration for the best results in planer work is the foundation for the machine. This should be of brick or concrete and the machine should be carefully leveled up with the platen removed.

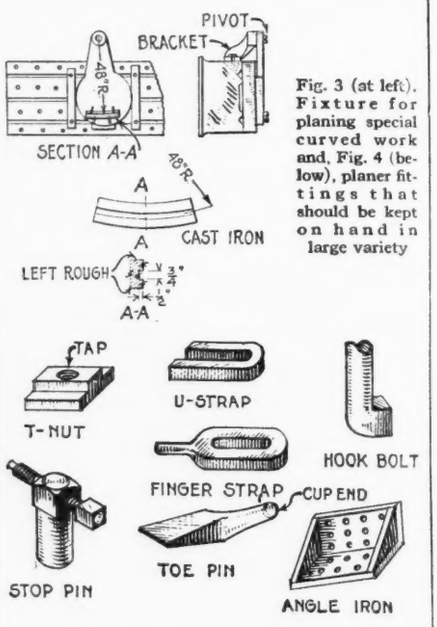

Fig. 3 (at left). Fixture for planing special curved work and, Fig. 4 (below), planer fittings that should be kept on hand in large variety

When a planer has been in use for several years it may develop errors that will cause considerable trouble in producing accurate work. General wear and rough usage, such as dropping heavy weights on the platen, cause this part to spring and warp out of its true plane. If this condition is very pronounced, the V's will have to be re-planed and then a light cut taken over the platen, or even several light cuts. Before taking this cut, the cross rail should be squared up with the V's.

Another important matter in getting the most out of a planer is the provision of an ample supply of bolts, nuts, clamps, pins, toe dogs, and so on (Fig. 4). These should be kept in a box near the planer. A junior apprentice may be assigned the task of keeping these articles in good condition. It saves a great deal of a mechanic's time in hunting up bolts and clamps or anything he may need for setting up a job. The supply of these articles cannot be too liberal, as a high priced machinist often is required to waste a lot of time looking for them.

(*Continued on page 83*)

How to Make the Most of Planer and Shaper

(*Continued from page 82*)

A few variable speed planers are built, but most of the planers found in the average shop run at one speed only and for this reason are rather slow for some classes of work. The speed of a planer may be set for planing steel at a cutting speed of 50 feet a minute and this speed will have to be used for brass or iron or any other metal, regardless of the theoretical cutting speed, unless the planer is one of the variable speed type.

So now we turn to the shaper, a machine that is actually a planer in the sense that the cutting action of the tools is identical. Being a variable speed machine, the shaper will work much faster than the planer on many jobs, although it is not generally quite as accurate.

Especially in cases where true parallel surfaces must be obtained, it requires

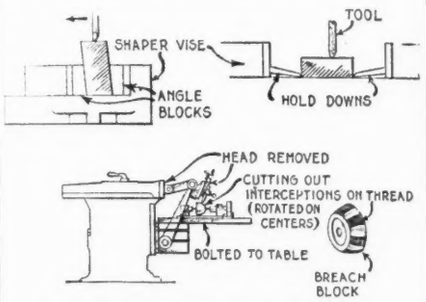

Fig. 5. Holding angular work in a shaper vise and one method of shaping curves

considerably more skill to produce perfect work on the shaper. Shapers develop inaccuracies more rapidly than does the planer. This is due to a number of causes; first, there is always a tendency of the tool to spring away from the work, particularly on long strokes and heavy cuts; second, lack of rigidity in the ram when the guides become worn and loose; third, the table sags and gets out of alinement with the ram, and, fourth, the work itself often springs. These are sources of error not common with other machines, and, in addition, it is difficult to keep the shaper always in perfect condition. With all these limitations, however, the shaper has many advantages over the planer on small work and short cuts.

Planing curved and irregular surfaces is done on the shaper much the same as on the planer, by the use of special fixtures attached to the machine (Fig. 5).

To get the most out of a shaper, the machine must be in the best possible condition at all times, abundantly supplied with tools and other necessary accessories, a good shaper vise, wrenches, parallel strips, bolts, clamps, and the like. The gibs should be inspected frequently and kept properly adjusted and the whole machine should be thoroughly and properly oiled.

Any inaccuracies existing in planers and shapers are usually discovered by the cut and try method, although they may be ascertained by testing. Testing the accuracy of a machine is best accomplished by using a dial test indicator, square, and level.

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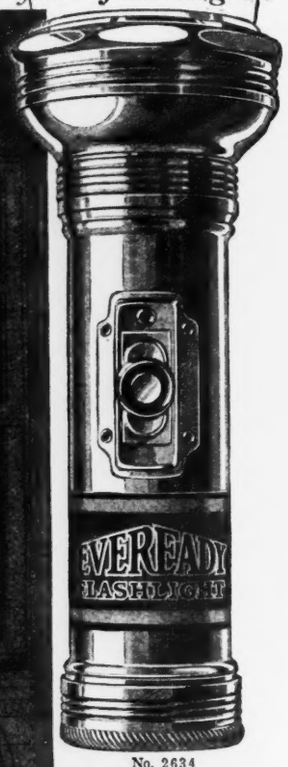

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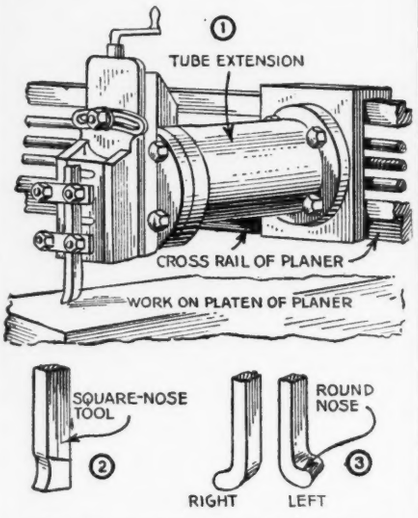
Three Shaper and Planer Ideas that Will Save Time

By F. J. Wilhelm

SOMETIMES it is necessary to produce a circular surface on some part of a job that will not swing on centers. In many cases a job of this kind may be handled on the shaper. In the central illustration on page 76 is shown a typical job of this sort and how it is held in the shaper vise. An arbor is made to fit the hole. It has a shoulder for the piece to butt against and is threaded on the outer end for a nut. There should be a washer between the nut and the work. Draw up the nut just tightly enough to allow the work to rotate on the arbor with a little friction. Set the tool in the center of the



Extension head for planer and a square-nose tool that replaces two bent tools

work and roll the piece around to the point where the circle starts. Feed the tool in to the depth of cut desired and feed the work to the tool by pulling it around by hand just enough to take a normal cut.

An extension head is a valuable planer accessory for tools that will not pass between the housings of a small planer. These devices are usually homemade affairs and cost very little.

In the accompanying illustration, Fig. 1 shows a strong, yet simple design of extension head. It is made from a pipe of large diameter and two cast-iron pipe flanges to match. The pipe may be as long as necessary and the diameter will be governed to some extent by the diameter of the bolt circle on the saddle.

When taking a side cut with a down feed on a shaper or planer, a square nosed tool (Fig. 2) with the corners well rounded is superior, I find, to any other style. When set over at an angle to the work, it will get under the scale and follow a straight line much better than the conventional bent, round-nosed tools. The latter style (Fig. 3) must be made in pairs, one right and one left, but the square-nosed tool may be used on the right or left with equal facility and without any change of form. In addition to being more efficient from a production standpoint, there is also a considerable saving in tool steel investment.

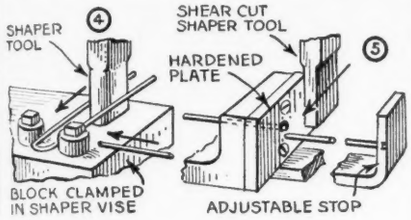
Additional Shaper Shortcuts

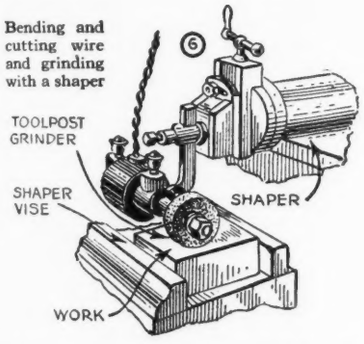
By Henry S. Laraby

BENT forms of wire and sheet metal may be produced with a shaper by the use of simple bending dies held in the vise (Fig. 4). The usual way is to cut the wire to the proper length and lay it on the die with one end against the stop. The two guide studs pass through rollers, which reduce the friction. The shaper is run at any suitable speed and the pieces of wire may be put in place without stopping. Set the stroke just long enough to push the bent form out of the die and leave it clear for the next piece.

The use of a cutting-off die, like the one shown in Fig. 5, is a rapid and economical method of cutting off wire lengths.

Surface grinders are hard-worked machines. When you are unable to get a machine or the shop lacks one, a shaper

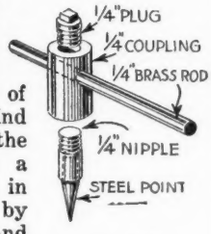




may be a life-saver for a rush job. With an ordinary portable toolpost grinder, the shaper will do an excellent job. The grinder and the work is set as in Fig. 6.

Simple Shop Trammel Made Mainly of Pipe Fittings

A TRAMMEL head may be made easily by using a ¼-in. pipe coupling, a ¼-in. plug, a ¼-in. nipple 1½ in. long, and a piece of ⅜-in. drill rod 1 in. long. Drill a ¼-in. hole in the coupling ⅜ in. from the end for the trammel bar, which may be ¼-in. brass or steel welding rod. The plug is screwed into the upper end of the coupling to bind this rod. Grind the short steel rod to a point and insert it in the nipple either by heating the nipple and shrinking it on, or by soldering or brazing the parts together. Screw the nipple in the lower end of the coupling. A piece of chalk or a pencil may be used in place of one of the steel points.—WM. H. WRAY, Toronto, Ont.



A trammel head

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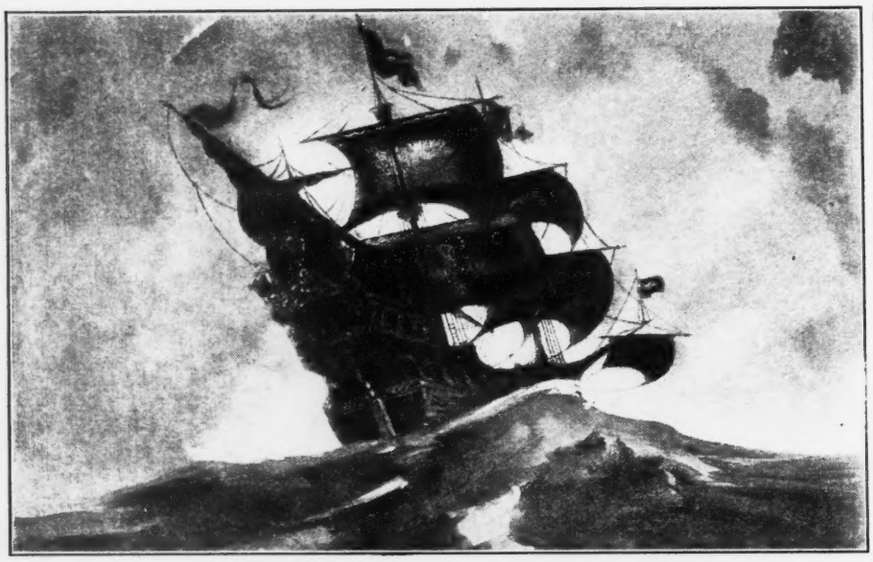

The Spirit of Pioneering

Impatience with present facilities, a restless searching for perfect things—these have driven men to discovery and invention. They possessed the early voyagers who turned their backs on the security of home to test opportunity in an unknown land. They explain the march westward that resulted in this settled, united country. And they have inspired the activities of the Bell System since the invention of the telephone.

The history of the Bell System records impatience with anything less than the best known way of doing a job. It records a steady and continuous search to find an even better way. In every department of telephone activity improvement has been the goal—new methods of construction and operation, refinement in equipment, discoveries in science that might aid in advancing the telephone art. Always the road has been kept open for an unhampered and economic development of the telephone.

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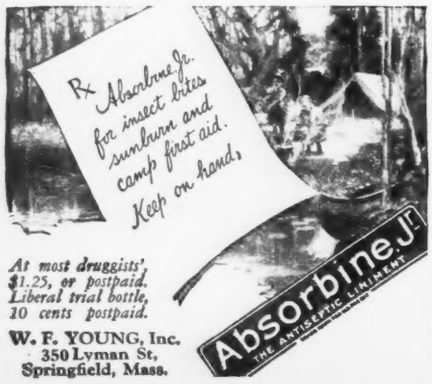

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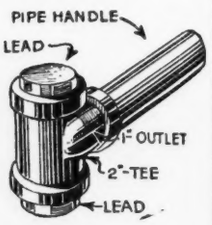
Side Outlet Tee Forms Head of Lead Hammer



THE lead hammer illustrated will not become battered as rapidly as the usual type. It also will strike a more balanced blow, as the hang of the hammer is little disturbed by constant use, owing to the side wall reinforcement.

A 2-in. tee with a 1-in. side outlet is used; the handle consists of a piece of 1-in. pipe. A ring is set over the outer ends when pouring the lead so that there is a projection of lead about 1 in. on both sides.

How to Remove a Battered Toolpost Screw

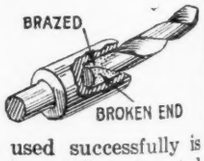
TOOLPOST binding screws often become battered or upset on the end so that they cannot be removed. Continued use in this condition makes matters worse; sometimes the screw gets so bad that it cannot be moved at all. The principle cause of this is a soft point.

To remove a screw in this condition is a simple operation. Place the head end of the screw in a vise, insert a hacksaw blade through the tool opening, turn the blade at right angles to the frame, and saw a slot about 1 in. deep. Then saw another slot at right angles to the first. This leaves four quarter sections that can be broken out easily with a chisel. The screw then may be removed.

Lathe Center from Shank of Broken Drill

ONE of the lathe hands in the steel plant with which I am connected complained that the tail center on his lathe was too soft. Told to make a new one, he selected from the scrap pan a broken high speed drill. This he cut to the required length and machined the end. The working end he then had hardened in the tempering room, after which he ground the point. Several centers have since been made in the same way at half the cost of our previous method.—F. N. C.

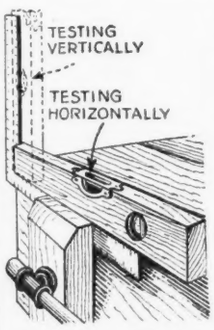
Brazing Broken Twist Drills in Special Shanks



WHEN large size twist drills are accidentally broken, it pays to salvage them if possible. A method I have used successfully is illustrated. The broken drill is inserted in a special shank made as shown and brazed in place. This is cheaper than buying a new drill.—H. W.

Adjusting a Carpenter's Level with a Steel Square

A CARPENTER'S level may be adjusted accurately by the method illustrated. A steel square is clamped in a bench vise with the tongue, or short part, vertical and with the blade, or long portion, horizontal.



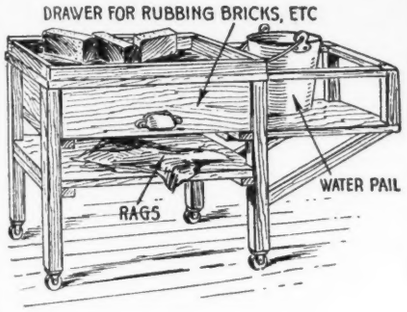
How the level is tested for accuracy

For horizontal adjustment place the level on the square blade and note carefully the position of the bubble. Then turn the level end for end and again note the bubble's position. Loosen the vise and tilt the square to bring it exactly level. Turn the level adjusting screw until the bubble is exactly centered and the level registers the same turned either way.

Since the vertical tongue of the square must be exactly plumb, proceed to adjust the plumbing level glass by testing the level in a vertical position.

Be careful to place the level squarely on the square, for a diagonal tilt in either direction will affect the result.—F. W. P.

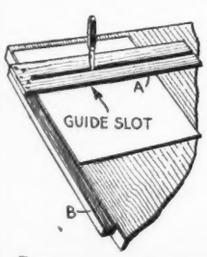
Stand Holds "Rough Stuff" and Varnish Rubbing Materials



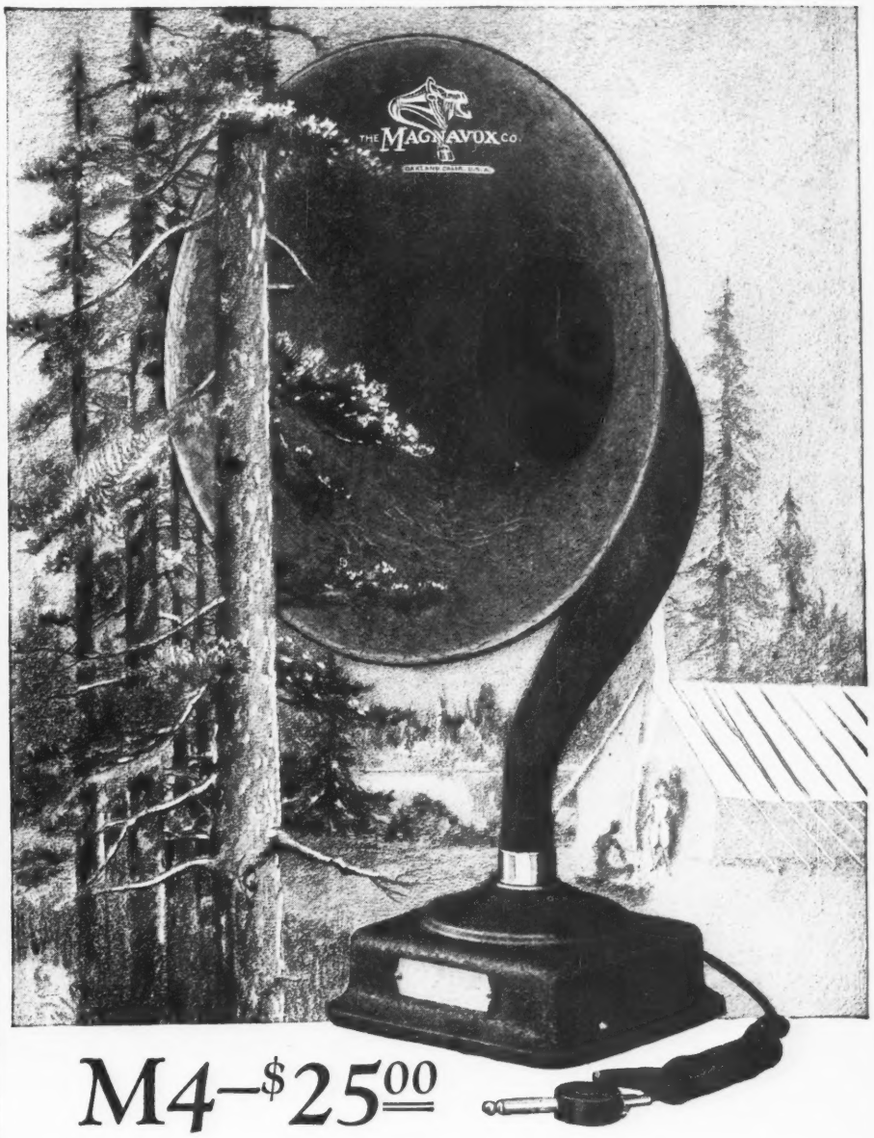
COLOR varnish and "rough stuff" rubbers will find the portable stand illustrated a convenience on the rubbing-deck. It can be constructed by the handy man of the shop from lumber usually on hand for repair work.—VERNON F. CLAYTON.

A Trysquare with Knife Guide

CARDBOARD, heavy paper, tracing cloth and similar materials can be cut rapidly and accurately by using a try-square made as shown. A slot just wide enough to allow the knife to work freely is cut through the center of a leg of the square, parallel with the edges. The square should be hard wood and all edges should be smooth. The knife is placed in the slot and drawn toward the operator.—JAMES E. NOBLE.



For cutting cardboard, paper and cloth



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is the only drill with adjustable tension. It has seven different tensions. No other drill but this has a magazine handle that opens up toward the chuck, exposing eight drill points, heads up, for easy selection.

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"YANKEE" TOOLS

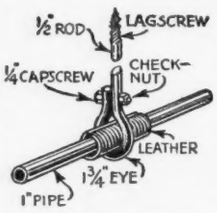
Make Better Mechanics

Saving Floor Space in a Crowded Machine Shop

By Dwight Donald

IN SMALL shops, with the present high cost of rented buildings, it is often a problem to obtain the necessary floor space. All such shops have machines that are used only occasionally. The area occupied by them frequently can be used to advantage for extra bench room. Skeleton benches with solid tops are built and braced between both pairs of end legs and one pair of side legs, in such a way that when mounted on casters they can be rolled over any low-built machine. For several years past this arrangement has served a dozen different uses in my own shop.

We also have economized space by building in closets under tables and by hanging a closet from the ceiling against the wall. The latter, which has swinging doors on the side and ends made of matched boards, keeps office supplies and shipping material free from the greasy dust that is the bane of the machine-shop office.



A conductor tube for screw machine

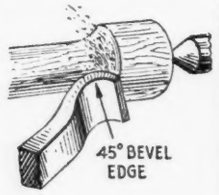
Additional space has been gained by doing away with the pipe rod standards commonly used in connection with automatic screw machines. The conductor tubes now hang from the ceiling, parallel to the floor, each supported at either end by a ½-in.-diameter wire rod. Not only is floor space saved, but the terrific noise and vibration of the screw stock revolving in the tubing as it feeds into the automatic is much reduced.

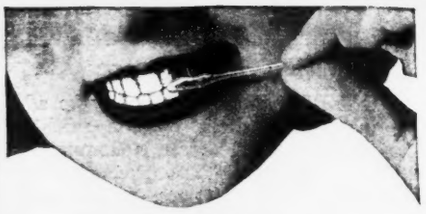
The hanging rods should be cut to the proper length with allowance for bending the eye, 1¾ in. inside diameter. This provides room for a leather collar to be wrapped around the pipe passing through the eye. The leather acts as a silencer and reduces vibration. Above the loop a 5/16-in. clear hole should be drilled, parallel to a plane passed through the eye, and extended as a ¼-in. tapped hole through the tail of the loop directly opposite. A binding screw then can be passed through the two parts of the loop and a check nut screwed on, to clamp the eye firmly around the leather collar and feed pipe.

A ½-in. lagscrew should be welded on the upper end of the rod to screw into the beam or planking above. This device has been used in connection with our several automatics for five years.

This Special Woodturning Tool Makes Deep, Smooth Cuts

A WOOD-TURNING tool shaped as shown takes a very deep cut and leaves a smooth finish. It works equally well in a wood-turning or an engine lathe. Regular tool steel bar stock is used. It is drawn out to a taper, bent to a semicircular form and tempered.





How Bleachodent Whitens Dark Teeth In Three Minutes

Bleachodent Combination contains a mild liquid to soften stains—and a special paste which gently removes them. Dull, yellow or tobacco-stained teeth are made flashing white, sparkling clear—almost while you wait! Perfected by two prominent dentists. Just use liquid once a week—paste every day. **Keeps** teeth wonderfully white and lustrous. Don't go around with bad looking teeth. They spoil appearance, and besides cause tooth decay, and bad breath. Get Bleachodent COMBINATION (containing both liquid and paste) for small cost. Distributed by Bleachodent Dental Laboratories and sold by drug and department stores everywhere.

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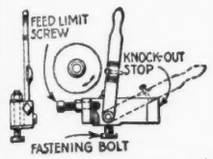
Screw Heads Slotted Rapidly in Simple Lathe Fixture

THE owner of a small shop sometimes has the job of slotting a number of machine-screw heads. To do this with a hacksaw is tiresome. It is much quicker to use the rig illustrated.



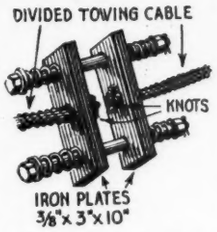
For slotting screws

The base is made from a piece of steel 2 by 2 by 5½ in., with a recess machined on one side and with two projecting lugs. One lug acts as a knock-out block; the other is drilled and tapped for a ⅜-in. feed limit screw. A hole is drilled in the proper location for the fastening bolt.

The hand or feed lever is fastened to the base with a ⅝-in. stud or cap screw. This lever is drilled in the proper location—according to the center of lathe—to receive the screws to be slotted. If many sizes are to be slotted, the hole may be drilled large and bushings of various sizes made to fit the screws.—F. N. C.

A Shock Absorber for an Auto-Towing Cable

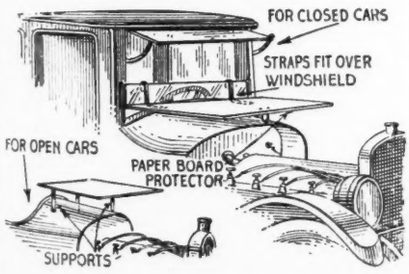
MATERIALS taken from the junk box were used in making the tow-cable shock absorber illustrated. The two plates are drilled at each end with bolt holes, and in the center for the cable.



For smooth towing

If a steel cable is used, the ends may be sweated in place; if ordinary rope, the ends are knotted. The springs used are automobile clutch springs, although any fairly heavy springs will serve the purpose.—HARRY G. SCHULTZ.

Stiff Protectors Shield Freshly Varnished Surfaces from Dust



LIGHT protectors made of wood, wallboard, or cardboard are useful in keeping dust and dirt from settling on freshly varnished horizontal surfaces. Two applications of this idea to automobile finishing are shown, one for use with closed cars and the other for open cars. The same method can be used to protect furniture or other woodwork while varnish or enamel is drying.—V. C.

"The Critic"

ALL creative effort comes in for its share of criticism. You know that—that is, if you've ever tackled one of those round-the-house carpenter jobs. But maybe the criticism should have been directed at your tools!

Why not head-up your tool kit today with a Simonds Hand Saw, Hack Saw and File? They're produced by an organization experienced in making cutting edges of tempered steel since 1832. They're RIGHT!

Ask your dealer today, but be sure you pronounce the name SI-MONDS.

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All Set to Produce What?—and When?

Your machine is "all set" to deliver the product—at the best rate you've developed in its design.

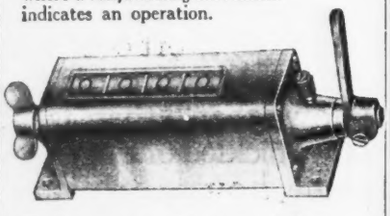
Then the question: "What *IS* its best rate of work?"

Next the question: "How to know *when* it's *DOING* its best?" —as indicating whether it's well operated and watchfully run.

Better equip the machine to turn out something besides question-marks. Make it turn out *production records*—on a

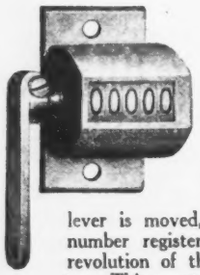
Veeder COUNTER

The Set-Back Rotary Ratchet Counter below is for machines such as presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.



Registers one for each throw of the lever and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $11.50—subject to discount. (*Cut less than ½ size.*) Set-back *Revolution* Counter of similar model, $10.00 (*list*).

This small Rotary Ratchet Counter (No. 6) counts reciprocating movements of the lever, as required for recording the output of innumerable small machines. When the lever is moved through an angle of 40 to 60 degrees, the counter registers one. The further the lever is moved, the higher the number registered. A complete revolution of the lever registers ten. This counter can be adapted to no end of counting purposes, by regulating the throw of the lever. Price $2.00. (*Cut nearly full size.*) Small *Revolution* Counter, also $2.00



Everything you could use in a counting device is shown in the 80-page Veeder booklet. Your request brings it promptly.

The Veeder Mfg. Co.
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How to Outwit the Shrinkage Jinx

A FRIEND of mine, the other day, was being entirely too conscientious in the construction of a cabinet. He was working on a pine buffet top, about 20 in. wide, glued up from two boards; and across the under side he had glued and nailed 1 by 2 in. cleats to make what he thought was a very solid and substantial job.

"I'm sorry to see you putting those cleats on in that way," I remarked.

He looked at me in surprise. "Why," he replied with some heat, "you know how hard it is these days to get well-seasoned materials. If I don't put on the cleats, this top will simply warp until soon it will be of no account at all."

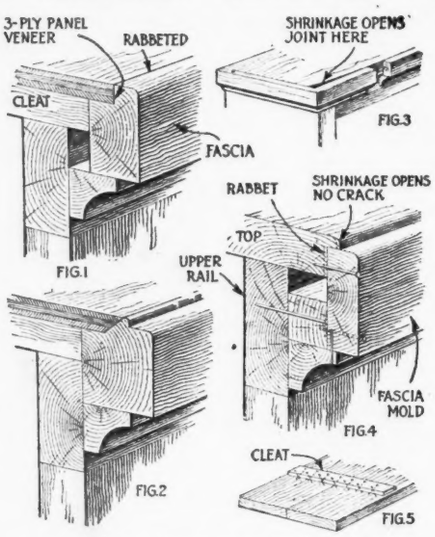
"You are building against one fault of shrinkage while ignoring another," I said. "Leave off the glue from the cleats and you will be all right."

My friend was entirely correct in guarding against warping. All carpenters and most amateur woodworkers know that there is only too little thoroughly seasoned soft wood to be had; and the old rule of gluing up boards with heart and sap sides alternately up to minimize warping is largely useless, since the heart side of a board, though growing nearer the dry interior of the tree, may actually contain more moisture than the sap side because of having been ripped from the sap edge of a timber that had dried out fairly well on the surface, but was still green in the center. And even with the right material, the rule hardly helps where wide stock is to be glued edge to edge. Stock 20 in. wide will shrink ⅛ in. across the grain and it must be taken for granted that this will occur.

If, therefore, the cleats are glued, the enormous force developed in shrinkage is unable to draw the outer edges toward each other, as it could if the top were lying free, and it relieves the strain by attacking the weakest points in the top—oftentimes the glue joint, or a check or windshake not seen when the top was made. That causes splits in the top and the parting of the boards at the joint.

On the other hand, if the cleats are merely nailed on (Fig. 5) with short nails driven in at various angles to obtain a dovetailing effect, there is enough resistance to the shrinkage of top or bottom surfaces to prevent warping. At the same time, the side spring in the nails is sufficient to allow the front and back edges of the wide board to be drawn toward the center. In nearly every case, checks are avoided. This is equally true for screwed-on cleats. If, to strengthen the glue joint, additional reenforcement seems essential, apply glue to the cleat for an inch each side of the joint.

Since shrinkage will show itself on a cabinet, it should be disguised as far as possible. Figure 1 shows a favorite way of finishing the edges of the cabinets often built in modern homes. A molding is run around the edge and ends of the top, giving it a heavy, ornamental appearance. But the grain of the end moldings is across the width of the cabinet top, so that when the top shrinks, if it is solid and not plywood stock, it will draw away from the front fascia. The end molding will prevent the front molding from following the top in its contraction. These openings, as in Fig. 3, are defects to be noted in many well-built houses and on dressers, tables, and other articles made by amateur woodworkers. Shrinkage, however, can be disguised.



In concealing the effects of shrinkage, Figs. 2 and 4 are better than Figs. 1 and 3

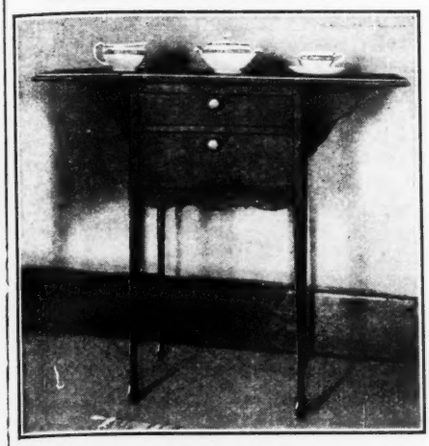
Drop the upper edge of the fascia mold ⅛ in. or more below the edge of the top, and fit the top into a rabbet in the molding, as shown in Fig. 4. When the top shrinks, more of the upper edge of the fascia will be uncovered, and the paint or varnish will break at that point; but no light can be seen through and the exposed wood will not be noticeable.

In the building of cabinets in a house, the use of 3-ply panel veneer ⅜ or ⅝ in. thick for tops is recommended. No shrinkage takes place in this material, and the outside veneer, extending the full width of the top, is without joints and presents a fine grain for staining. Cleats may be glued to the under side for stiffening, and the finishing of the edges may be as shown in Fig. 2.—E. L.

Refastening Brush Backs

METAL backs of hair brushes that become loosened, may be replaced permanently by the use of sealing wax, such as is used in canning. All the old fastening material in the metal shells should be removed. Fill the shells nearly, but not quite, full of sealing wax melted sufficiently to run well. Press the top flat surface of the upper part of the brush down into the soft wax in the same position it occupied before becoming loose. Cut off any surplus wax around the edges. Within a short time the wax will harden and the brushes will be as usable as ever. The wax should not be re-melted by immersion in unnecessarily hot water, which would injure the bristles as well.—G. E. B.

Blueprints Offer Many Good Ideas to the Home Worker



HOW valuable the Home Workshop series of blueprints is to home craftsmen is indicated by the above photograph, which shows a sewing cabinet based on POPULAR SCIENCE MONTHLY'S Blueprint No. 1. This exceptionally fine piece is the work of Rufus E. Deering, of Clements, Kan.

Mr. Deering prepared the article on constructing a walnut chair on page 73 of the July issue. When a craftsman of his ability makes use of the blueprint service, it is obviously to the advantage of woodworkers of less experience to avail themselves of these careful plans.

Complete List of Blueprints

ANY one of the blueprints listed below can be obtained from POPULAR SCIENCE MONTHLY for 25 cents. The Editor will be glad to provide, upon request, information relative to tools, material, or equipment.

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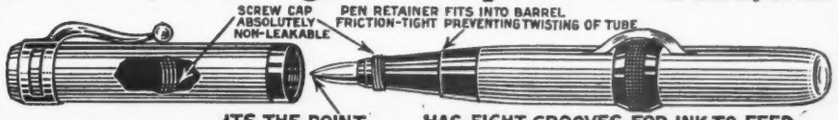

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Building Radio into Your Home

(*Continued from page 71*)

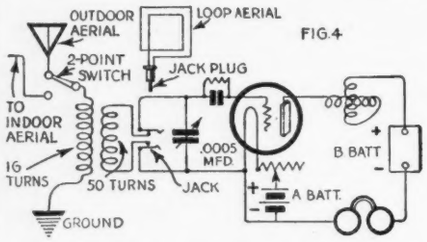
type of wiring is shown that provides an aerial and ground outlet in several rooms. This method of wiring is for use with a commercial set that has a built-in loudspeaker and the whole set is intended to be carried wherever it is used.

All outlets should be connected in parallel, as Fig. 1 shows.

The set required is the same as for operating an individual loudspeaker. Ordinarily one corresponding in volume to a regenerative set with two stages of audio-frequency amplification is ample.

In the summer, it is often desirable to change aerials to suit the atmospheric conditions. For this it may be well to provide the regular outdoor aerial and a second one, consisting of about 1 lb. of bell wire strung around the picture molding, or an inside aerial stretched through the attic. A single-pole rotary switch, with two contact points, will enable the change to be effected instantly.

When static or other interference is very troublesome, a loop aerial is a lifesaver. If a regenerative set, using a



Wiring diagram, showing method for connecting outdoor, indoor, or loop aerial at will

coupler with a variable condenser connected across the secondary, is used, it may be converted readily for use with a loop by connecting a double-circuit jack in the circuit, as in Fig. 4. The plug is attached to the end of the upright post of the loop and plugged in whenever needed.

If a phonograph with a cabinet is available, it is an exceedingly good plan to build the set right into it. This will save space, insure an artistic cabinet, and make use of the mellow tone resonance of the usual phonograph sound chamber.

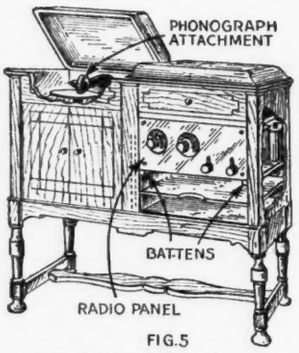
The style chosen for illustration in Fig. 5 is a typical one, and will serve well for an example. In one side is located the reproducer and the horn, and in the other are the shelves for records.

Measure the distance between the two walls of the record compartment, and cut your panel to that length. The height necessarily depends upon the particular apparatus you must mount, but will generally be the equivalent of the space between two or three record shelves.

A baseboard of wood, from $\frac{5}{8}$ to 1 in. thick, of the width of the panel, should be fastened to the panel with screws and brackets. The depth of this should be governed by the depth of the cabinet, allowing, of course, for the thickness of the panel and the amount of set-back that is necessary to take care of the projection of the dials. Leave ample room for the door or doors to close.

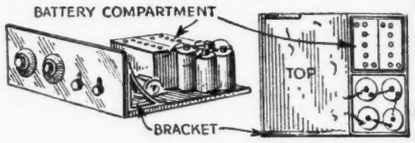
If you use dry-cell tubes, it is entirely feasible to include both the A and the B batteries within the cabinet. Partitions of thin wood will help keep them in place.

If the cover does not open so as to make the batteries accessible when they have to be inspected or changed, a door will have to be made in the back of the cabinet, or else the entire set will have to be re-



Typical way of installing set in phonograph cabinet, with doors omitted for clearness. The set is a removable unit, as shown below

FIG.5

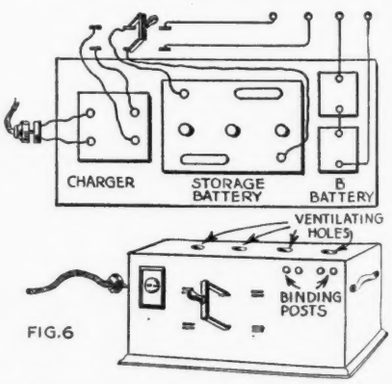


moved bodily each time a change is to be made.

Strips of wood, about $\frac{1}{2}$ by $\frac{3}{4}$ in., are fastened with screws to each side of the inside of the cabinet to serve as a support, upon which the base can slide like a drawer. A vertical strip of similar material should be fastened on each side, extending from the top of the cabinet to the upper side of the base. Two screws through the panel at each side into these strips will hold all the apparatus securely.

In upright types of phonograph cabinets, a set may be placed in the record compartment or even built to fit into the cover if it is fairly deep. How this can be done may be observed by studying the ingenious arrangement of parts in commercial sets sold to fit into phonograph lids.

If the tubes used require a storage battery for their economical operation, this



Battery-charging box and diagram showing arrangement of parts and wiring diagram

will have to be left outside. The next best plan is to build a separate battery box. In Fig. 6 is suggested an arrangement by which a storage battery, its charger, and the necessary B battery may be placed

(*Continued on page 93*)

Building Radio into Your Home

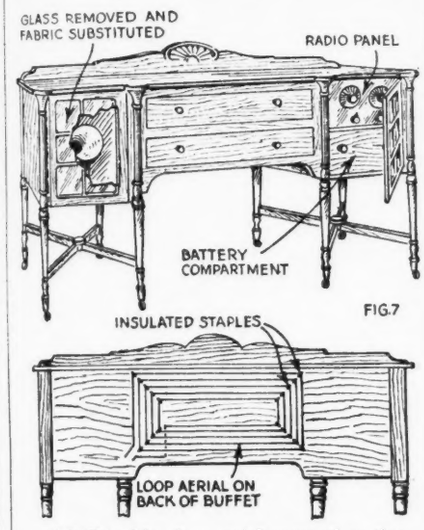
(*Continued from page 92*)

in one box and the whole hidden under the console, or even in another room.

A double-pole double-throw knife-switch is mounted on the front of the box, along with an electric-light plug outlet and the A and B battery binding-posts. By throwing the switch to one side, the battery is placed on charge, and by throwing it to the other side, it is connected with the set. Holes should be drilled in the top of the box to allow the escape of the battery gases.

In the dining-room, a radio set can be built very easily into a buffet (Fig. 7). One of the type shown is especially adaptable. In the space below the panel an inside door can be fitted to divide the interior as a battery compartment (see upper illustration).

The loudspeaker can be mounted behind the door on the other side of the



A buffet with a loop aerial mounted on the back makes an excellent radio cabinet

buffet. Remove the glass from this door, if there is any, and substitute a sheet of some thin fabric of a color to correspond with the woodwork. Otherwise make a removable framework to go just inside the door and cover it with silk to match the room's color scheme.

With an installation of this kind, a large loop can be concealed behind the buffet, but a great deal of its effectiveness will depend upon the direction in which it points in relation to the direction of the stations from which reception is desired. If the chief stations all lie in a single general direction, the buffet can be so set that the edge of the loop points in that direction.

The loop may be bell wire fastened to the back with insulated staples. The exact number of turns necessary is determined by the diameter of the loop, but will probably range between seven and 15.

Unit sets, mounted on baseboards as described, can be mounted in innumerable pieces of furniture and odd corners about the house. Corners of closets, medicine cabinets, bookcases, and sewing-tables, all lend themselves readily for this purpose. A compartment of a sectional bookcase makes an exceptionally fine case for a set.

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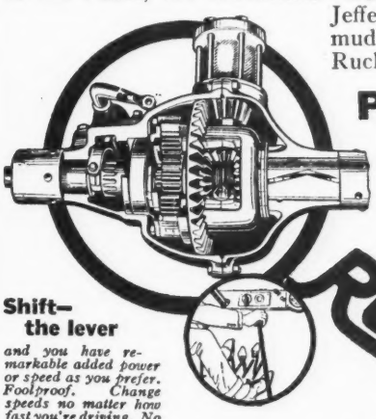

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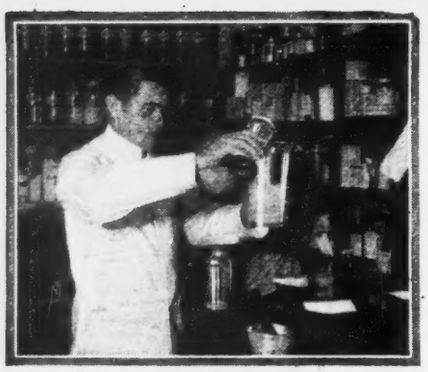

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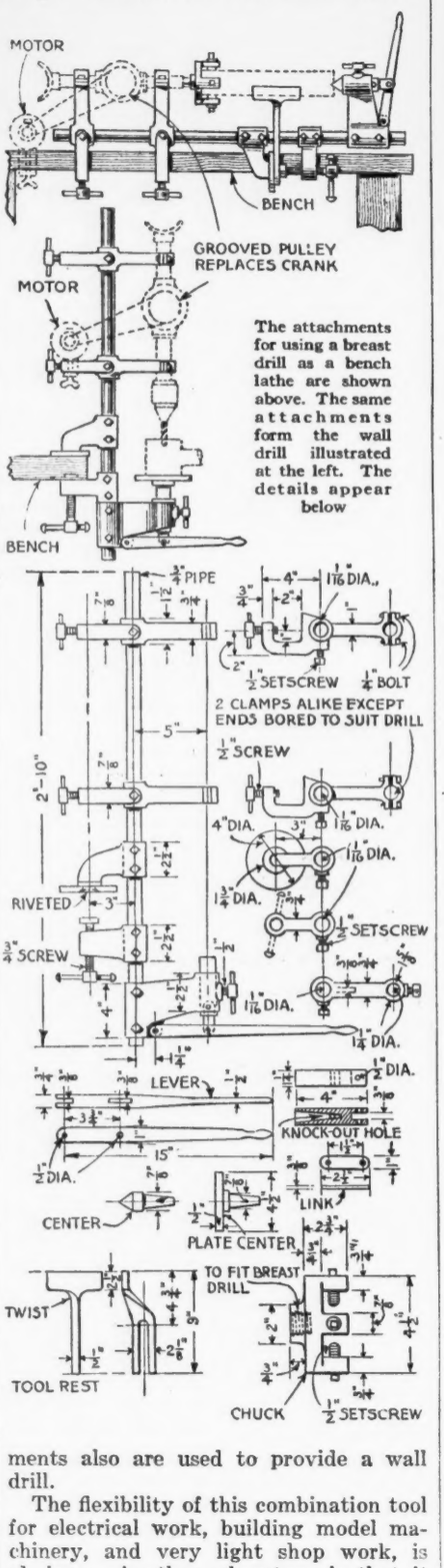

The attachments for using a breast drill as a bench lathe are shown above. The same attachments form the wall drill illustrated at the left. The details appear below

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(Continued on page 95)

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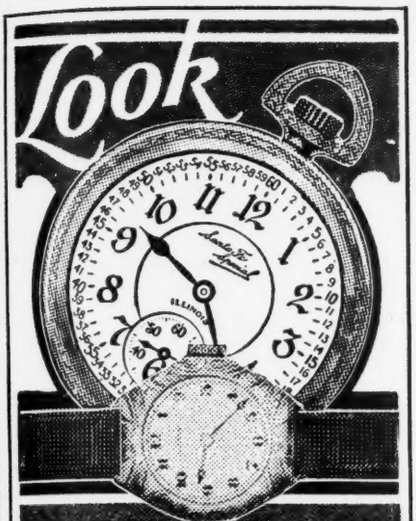

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Attachments for Breast Drill

(*Continued from page 94*)

workbench and requires no special wall supports or stand.

A grooved pulley is substituted for the drill crank. A small electric motor, such as a sewing machine motor, provides the power, or the pulley can be belted to the flywheel of a treadle.

A round shaft or pipe forms the main frame or bed of the machine. Two forged arms, made as shown, support the breast drill. The next member is a forged bracket with a faceplate that supports the frame when used vertically as a drill press, and holds the adjustable toolrest when the device is used as a lathe.

The tailstock is fitted with a sliding shaft and tapered center. A plate is substituted for the center when the machine is turned up to serve as a drill. A lever and link operate the sliding shaft in the tailstock.

The drill chuck is replaced, when necessary, with a simple chuck to hold parts up to 3 in. in diameter.

All the parts are fastened to the frame or bed with setscrews and can be adjusted to suit requirements. The breast drill can be removed and the crank replaced in a few minutes to restore it to its ordinary use.—G. L.

Cushioning Kitchen Faucets with Crutch Rubbers

AFTER several china dishes had been chipped or broken by being knocked against the sink faucets, I placed ordinary crutch rubbers over the ends of the taps to prevent further accidents.

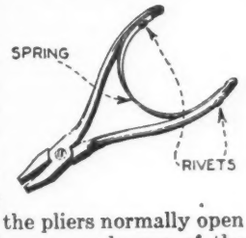
The rubber prevents breaking china

The rubbers were obtained at a five and ten cent store for 10 cents. A hole was cut in the bottom of each the same size as the opening in the end of the faucet.

Whenever desired, the rubber bumpers can be removed for cleaning. Cheap as they are, they do not look out of place in the most up-to-date kitchen. If crutch rubbers are not available, ordinary rubber stoppers, obtainable at any drug store, can be used if a smooth hole is drilled through each.—D. V. H.

Adding a Spring to Pliers

A PIECE of flat spring steel riveted to pliers handles as shown is a convenience for certain kinds of work. The tension of the spring keeps the jaws of the pliers normally open and therefore allows a ready use of the tool.—JACK PRINTZ.



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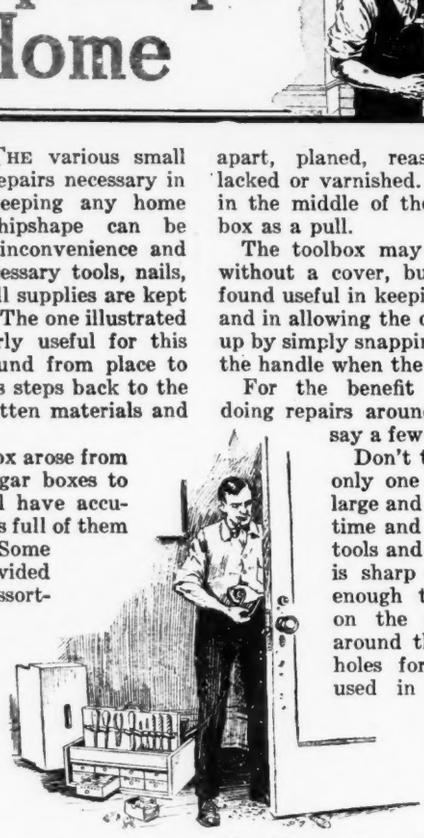
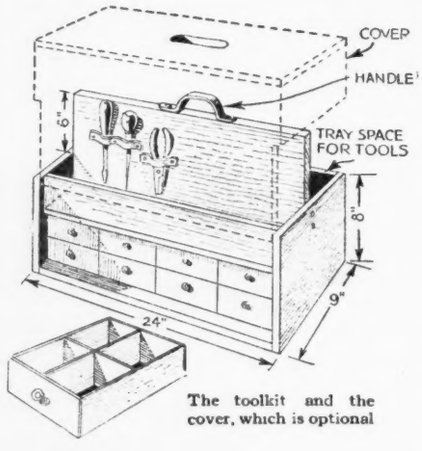
The Shipshape Home

Shipshape Home Toolkit

THE various small repairs necessary in keeping any home shipshape can be made with the least inconvenience and loss of time if the necessary tools, nails, screws, and other small supplies are kept together in a toolbox. The one illustrated has proved particularly useful for this purpose. Carried around from place to place, it saves needless steps back to the workshop to get forgotten materials and tools.

The design of this box arose from the fact that I use cigar boxes to store my supplies and have accumulated several shelves full of them in the course of time. Some of the boxes are subdivided into four parts for assortments of screws, tacks, and the like. Sandpaper, broken glass for scraping, spools of wire, friction tape and similar material occupy one or more boxes. Each box is lettered on the front to indicate the nature of its individual contents.





The toolkit and the cover, which is optional

When I start out to do a job anywhere in the house, I slip the cigar boxes containing the necessary supplies into the bottom part of the box. As I keep all the necessary tools in the top part, I am away without any bother.

For the beginner at home-workshopping, to coin a word, the box will contain all his tools for a considerable time and will remain a useful adjunct even when he graduates to a toolchest of his own.

The box should be made of light material, ½ in. or ⅝ in. thick, except the center board, which is ¾ in. A metal carrying handle, from the hardware store, is attached to the middle of the top of this board. To make a really workmanlike job, the cigar boxes should be taken apart, planed, reassembled and shellacked or varnished. A screweye is used in the middle of the front of each cigar box as a pull.

The toolbox may be made and used without a cover, but the cover will be found useful in keeping out dust and dirt and in allowing the contents to be locked up by simply snapping a padlock through the handle when the cover is on.

For the benefit of the beginner at doing repairs around the house, let me say a few words on tools.

Don't try to get along with only one screwdriver. Buy a large and a small one and save time and patience and broken tools and screws. An awl that is sharp pointed and sturdy enough to stand hammering on the end is very useful around the house in making holes for the small screws used in putting up shades, small brackets and the like.

When you get used to doing a few odds and ends, branch out and try the bigger jobs of making new things. A ratchet bitbrace with a few bits, a 9-in. smoothing plane, a good oilstone, and a saw enable you to do many jobs.

But above all, buy good tools. Have a place for them and keep them clean and sharp.—STANLEY W. BLANCHARD.

How to Lay Linoleum

HAVING had two coverings of linoleum on our kitchen floor, we decided to make the next application so permanent that it would last for years to come. Previously the linoleum was in narrow strips with seams that allowed the mop water to penetrate and rot it. To avoid this, we bought linoleum 12 ft. wide.

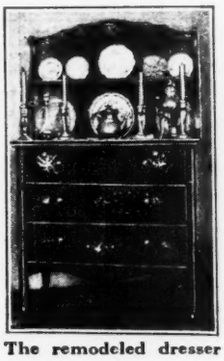
As the kitchen is 11 ft. wide, I used a pair of tinner's snips, the best thing in the world to cut linoleum with, and trimmed off 1 ft. from one side. After covering the floor with building paper, without which no linoleum should be laid, we rolled the linoleum over the floor, putting down a 16-ft. length with no seams whatever.

Our decorator advised us to give the linoleum several coats of floor wax, which we did. The wax is put on about 2 sq. yds. at a time and then rubbed down with a soft rag. This allows the surface to be kept always fresh and free from spots.

In my experience, inlaid linoleum should be cut at least 1 in. smaller than the floor it is to cover to allow for the expansion. After the linoleum has expanded and set, the door openings should be covered with brass strips and tacked well down.—HARRY C. MOSHER.

Discarded Furniture Converted into Ornamental Welsh Dresser

AN OLD-TIME dresser with a mirror held between lyre-shaped brackets formed the base for the Welsh dresser illustrated. The top was removed and a section was cut from an old bedstead to make the upper part of the dresser.



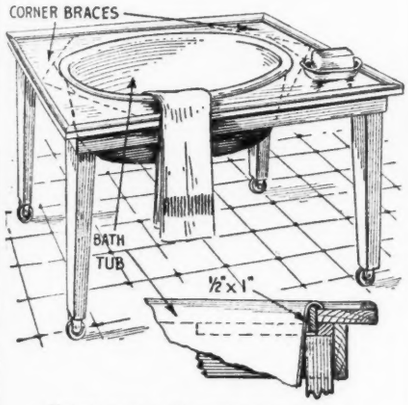
The remodeled dresser

A narrow ledge for plates was fastened across the center of the top board and the brackets that formerly held the mirror were used as the ornamental side pieces of the top. The tin pulls were removed and antique bronze handles substituted. The whole then was enameled black and ornamented with flowers copied from a Dresden plate.—M. L. CHERRY.

Special Table Lightens Labor of Bathing Small Baby

THE first step in building the baby's bath table illustrated is to obtain a white enamel tub with a rolled edge. Measuring from that, the top is made as for an ordinary kitchen table.

The outline of the tub opening then is laid off and diagonal braces put into place underneath, where they will not obstruct the table hole. The hole is sawed and around the rim soft pine boards ½ by 1½ in. are mitered and fastened with glue and brads, the brads being set in

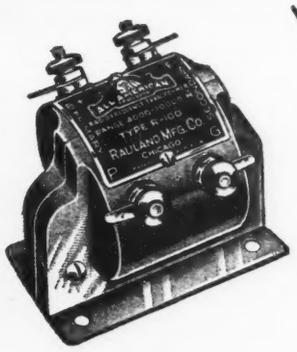


Baby's bath table with rims to prevent water from spilling on the floor

deep to allow for trimming the boards so as to fit under the rolled rim. Next, a ½-in. half-round beading is tacked and glued all around the outer edge of the table. The object of these two rims is to retain water splashed out of the tub.

Ball-bearing casters are provided so that the table rolls almost as easily as a baby carriage, and in any direction. Several coats of white paint finish the job.

A table of this kind has been in use for several months, and the baby's mother says she doesn't know how people ever manage to bathe babies without such a table.—R. W. E.



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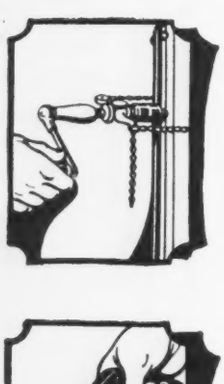

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Neat Radio Stand Cheaply Made from Old Bureau

A RADIO cabinet or stand of fine appearance often can be obtained at small cost by the simple expedient of remodeling a piece of discarded or second-hand furniture to serve the purpose.

If your own attic or storeroom has no old desk, wardrobe, bureau, or dresser that will do, visit several dealers in second-hand furniture and pick out what you think will work up to best advantage. Old music cabinets, phonograph record cabinets and desks of various types are well adapted for holding radio sets and batteries.

A roomy stand for a radio set

In my own case I used an old bureau of the 1860 style. Removing the top, I sawed off the case just under the top drawer and put the top on there. The second drawer, which was now the top drawer, was partitioned off for head sets and accessories.

Two lower drawers were removed entirely, as well as the division boards. Each side of the front then was closed by using part of a drawer front. The space between was left open for knee room. Shelves were put in behind the front boards to hold both the A and B batteries, one on each side. The only cost was for sandpaper and varnish.

At the back is a switchboard.—J. R. KOONTZ, Bremen, Ind.

Graceful Wrought-Iron Lamp

(*Continued from page 74*)

work will not be square when finished. The rivets securing the two smaller legs to the pipe should be staggered at least ½ in. so that they will pass each other in the center of the pipe.

The bracket holding the lamp socket is made adjustable for height by having the ⅜-in. pipe pass through drilled holes in the top and bottom members at such points that the curled end of the top member will press against it as a spring. This tension will hold the bracket in any position desired.

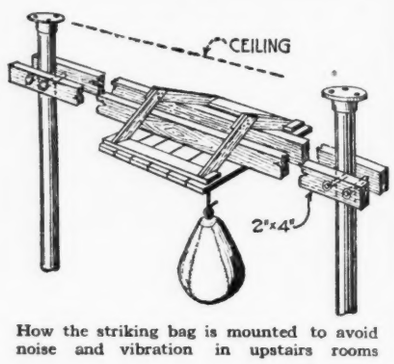
There is probably one other place where the amateur craftsman may spoil the looks of the project if he is not careful. This is in drilling and tapping the bracket for the attachment of the light socket so that it hangs parallel to the spindle.

The kind of shade, the method of attaching, and the finish of the lamp are more or less a matter of individual choice. A coat of black enamel was the finish used on the one photographed for this article. The shade is of parchment fastened to a frame that fits the end of the socket.

The wire of this lamp, as will be noticed, was run through the pipe, but unless the lamp is to be used in connection with a floor socket, it would be better not to do so, as it is a somewhat difficult undertaking on account of the rivets through the lower pipe.

Muffling a Punching-Bag Platform in the Cellar

WHILE a father almost always is glad to buy his son a punching-bag, there is usually no place to hang it except in the cellar, and then, if the platform is fastened directly to the ceiling, the whole house gets a shaking up whenever the bag



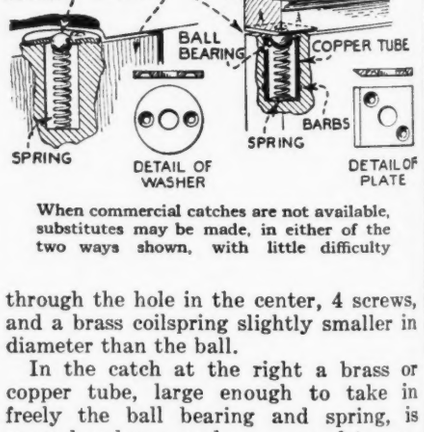
How the striking bag is mounted to avoid noise and vibration in upstairs rooms

is in use. To overcome this vibration, the striking-bag platform may be mounted as shown on the iron posts or brick or concrete piers that support the main girder under the first-floor beams. This arrangement also allows the platform to be adjusted in height.—F. S. ROOT.

How to Make Concealed Catches for Furniture Doors

BALL friction catches, so popular with both professional and amateur cabinetmakers for small doors, such as on radio, phonograph, and medicine cabinets, are not always easily obtained in the size needed. In that case they may be constructed from material usually to be found in the miscellaneous box.

The one illustrated at the left is made from 1 ball bearing, 2 washers just large enough so that a ball will not quite slip



When commercial catches are not available, substitutes may be made, in either of the two ways shown, with little difficulty

through the hole in the center, 4 screws, and a brass coilspring slightly smaller in diameter than the ball.

In the catch at the right a brass or copper tube, large enough to take in freely the ball bearing and spring, is swaged or hammered on one end to produce a lip, which projects on the inside and prevents the ball from coming out. A few barbs are cut on the outside of the tube with a sharp chisel to hold it in the hole, which is bored in the top edges of the door.

A square plate or washer let in flush with the surface of the wood, is used as a striking plate.—S. B.

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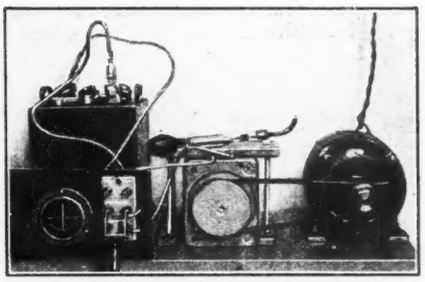
Assembling a Motor Generator Unit for Charging Batteries

By Arthur M. Vinje

FOR charging the storage A battery of my radio set, I assembled the motor-generator unit illustrated.

I happened to have the motor, but there is no reason why the motor of a washing machine could not be used, provided it is replaced not later than Sunday evening each week in its proper place on the washing machine. Otherwise you may hear from the *boss!*

The generator came from a dealer in used auto parts for $6. The ammeter, from the same source, cost 75 cents. Belt, pulley and switch were found in a box of odd parts accumulated from past adventures in my home workshop. The instrument board is a discarded radio panel.



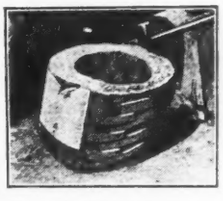
The charging outfit, with switch panel and ammeter, connected with a radio storage battery

The actual arrangement might have to be varied to suit individual needs. The method I adopted was to arrange the battery leads to go to the center posts of a double throw switch and the wires from the generator to the lower posts. Leads from the upper posts go to the radio set, so that it is unnecessary to move the battery for charging.

The generator set maintains a uniform charging rate of 3½ amperes, and could be used for charging any 6-volt battery.

The fact that the generator is driven a little below normal speed explains why this amperage is so low. In experimenting, I found that the generator developed about 14 amperes and seriously overheated when connected directly with the motor, the speed of which is 1750 r.p.m. Since the photograph was taken, I have changed to a gear drive and raised the charging rate to 5 amperes.

Hollow Block Holds Firewood Upright for Splitting



WHEN splitting firewood, I find the block illustrated is a great aid. The piece to be split is stood upright in the hollow center of the block, which prevents it from tipping over.

In hollowing the block, I first split it into halves, then chopped out the center and nailed iron hoops around to join the two halves together again. An 8-in. square piece of sheet iron is nailed on each side of the block to hold the splitting ax.—P. V. STUMP, Oxnard, Calif.

No Wise Man Goes Through This Twice

ONE session on the road with something loose in the bus and a flock of trick wrenches that won't fit where they're needed, is enough for any sensible man. Next time anything happens there's a Snap-on Kit under the seat that'll handle any nut or bolt on the car, whether out in the open or around a corner.

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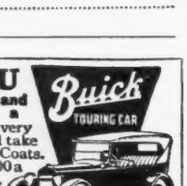

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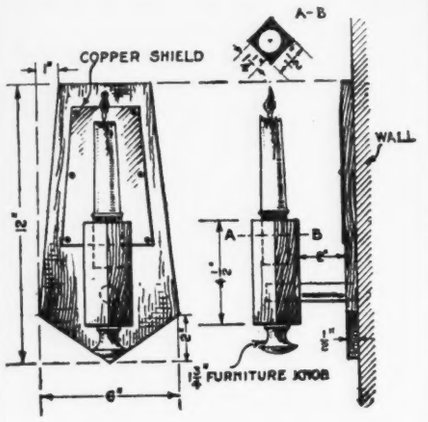
Making Decorative Candle Sconces for Wall Ornaments

A PLEASANT evening or two may be spent in the home workshop making and decorating a pair of sconces or wall candlesticks. These are popular just now and add a decorative note to the furnishings of any room. The sconce illustrated is easily made, yet it is ornamental when holding a bright-colored candle—one that matches the color scheme of the room in which it is placed.

Two pieces of wood, a furniture knob, a chair round or wooden dowel ¾ in. in diameter, and a 4 by 6 in. piece of thin copper, are all the materials needed.

The holder for the candle is 1½ by 1½ by 4½ in. with a 1¼-in. hole in one end.



Front and side views of an easily made, neat, and attractive candle holder

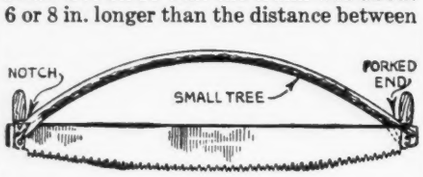
Notice that the sides of the piece are placed at an angle of 45 degrees to the back. If a lathe is handy, turn a small knob, to be fastened to the lower end of the holder. If no lathe is at hand, a 1¾-in. furniture knob, obtainable at any hardware store, may be used instead. Fasten it to the end of holder by gluing.

The sconce should be finished to harmonize with the furnishings of the room. Then fasten to the back a highly polished piece of copper, 6 in. long and shaped as indicated, using small brass round-head screws or ⅜-in. escutcheon pins.

A full size square or round candle may be put into the sconce, but the arrangement looks particularly well when the candle is burnt down a bit.—KENNETH R. LAVOY, New Rochelle, N. Y.

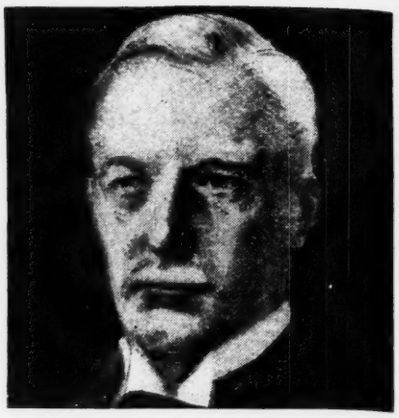
Adapting a Two-Man Saw for One Man to Use

TO MAKE it possible for one man to use a two-man crosscut saw, I cut a very small tree off so that the trunk was about 6 or 8 in. longer than the distance between



the two handles. On one end of the stick was a natural fork; the other I tapered like a wedge and then notched.

The stick was sprung into place between the handles to form a bow.—F. W.



NEW HYGIENE FOR MEN PAST 40

By Byram C. Kelly, A. M., LL. D.

MEDICAL authorities agree that 65% of all men past middle age (many much younger) are afflicted with a disorder of the prostate gland. Aches in feet, legs and back, frequent nightly risings, sciatic pains, are some of the signs—and now, a member of the American Association for the Advancement of Science has written a remarkably interesting Free Book that tells of other symptoms and just what they mean. No longer should a man approaching or past the prime of life be content to regard these pains and conditions as inevitable signs of approaching age. Already more than 10,000 men have used the amazing method described in this book to bring better health—and to restore the prostate gland to its proper functioning. Send immediately for this book. If you will mail your request to the Electro Thermal Company, 4036 Main Street, Steubenville, Ohio—the concern that is distributing this book for the author—it will be sent to you absolutely free, without obligation. Simply send name and address. But don't delay, for the edition of this book is limited. (Western Office, Dept. 40A, Los Angeles, Calif.)

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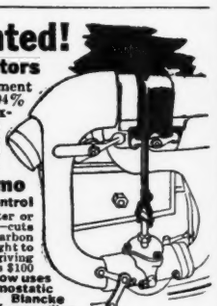

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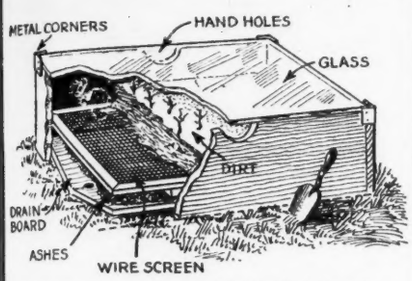
Improved Germination Box Gives Seedlings a Vigorous Start

SEEDLINGS have an excellent chance to grow sturdily when they are started in a germination box of the type illustrated. It is made of any available wood, from 8 to 12 in. deep, and with a bottom that slopes toward the center. Three holes along the center line allow surplus water to drain out.

Four blocks are nailed in about 3 in. above the bottom to support the screen



The layer of ashes and slanting drainboards aid in controlling moisture content of soil

frame. This is a light wooden rectangle covered with ordinary fly screening. At each of the four upper corners a piece of tin or sheet metal is fastened as shown to hold the glass cover-pane in place. Handholes in each side of the box allow the glass to be lifted when necessary and at the same time provide ventilation.

The lower section of the box is filled with ashes, which should not be too fine. These should be tamped down so that the screen rests on them. Above the netting is placed 2 or 3 in. of good soil, in which the seeds are planted.—W. F. SANDMANN.

Aerial and Ground Switches Are Useful in Testing Radio Sets

IN TESTING various radio sets on different types of aerials, it is often necessary to change the aerial and ground connections. This can be done quickly and easily if the experimenter will construct the switching panel illustrated.

Numbers 1, 2 and 3 are ordinary inductance switches. Switches Nos. 1 and 3 should have as many switch points as there are sets to be tested. Switch No. 2 should have as many switch points as different kinds of aerials are available.

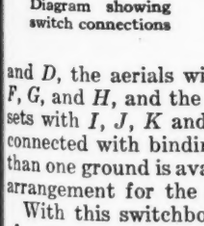


Diagram showing switch connections

In operation, the aerial post of the sets to be tested or compared are connected with binding-posts *A*, *B*, *C*, and *D*, the aerials with binding-posts *E*, *F*, *G*, and *H*, and the ground posts of the sets with *I*, *J*, *K* and *L*. The ground is connected with binding-post *M*. If more than one ground is available, duplicate the arrangement for the aerials.

With this switchboard, the aerial post of any set can be connected with any of the aerials available by movement of switches 1 and 2 to the corresponding switchpoints. The ground post of the set under selective test then can be connected with the ground by means of switch 3.

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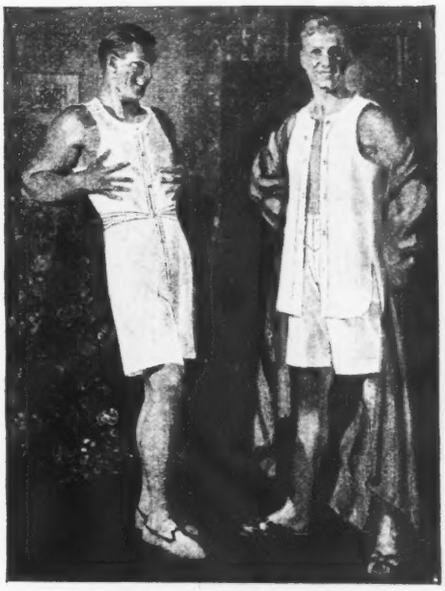

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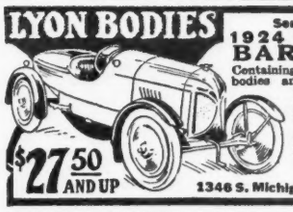

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How to Scrape Engine Bearings

By Ray F. Kuns
Principal of Automotive Trade School, Cincinnati, Ohio

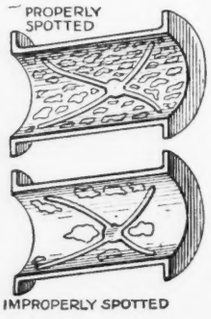
A MECHANIC came to me with a problem the other day. "Mr. Kuns," he said, "every time I drive this car a few blocks, I get a new knock. I have taken up the bearings a half dozen times, but inside of a mile the engine is knocking again. What is the trouble?"

An examination of the job showed that an oil line was clogged. The mechanic would set up the bearings, and, as soon as he drove the car far enough to warm it up, the main center bearing would burn out again. Finally he had to scrape in a new center bearing.

In a bad case of burned and damaged engine bearings, it is necessary to install new ones, as it always is when the wear is considerable and they cannot be adjusted or taken up in such manner as to insure satisfactory service. In either event, scraping is the usual method resorted to in refitting the job.

A possibility the experienced mechanic always bears in mind is that continuous service causes a coating of grit and glaze to be deposited on the surface of the babbitt. As the shaft must ride on this, protected only by the oil, it is likely to start cutting the shaft journals more quickly than would the babbitt itself. In many shops the practice is to remove this coating with a scraper and it is well known that this surface coating dulls the scraper rapidly. Once through it, the babbitt is soft and easily scraped.

A poor job of scraping, which shows the scraper marks (above), and bearings that have been properly and improperly spotted (at right)



The suggestions given last month in removing and reassembling bearings according to marks, must be observed when refitting bearings by scraping. Extreme care of shims is necessary. If a complete job of refitting is needed, then it is essential that the engine be removed from the car and turned up on the bucks or a bench to give easy access to the work. Prepare the job by cleaning inside and out with kerosene. Remove the transmission, flywheel, oil pans, cylinder head, and so forth.

REMOVE all rod bearings, remove and lay aside the piston and rod assembly, and remove all the caps from the main bearings. Next, lift out the crankshaft and test it for straightness. This is done by placing it on the bench with the two end bearings resting in V blocks. These may be wood or, better still, of brass or cast iron.

The center main bearings are tested to see whether or not the shaft is sprung. The gage may be made from a piece of wood clamped on the bench in such manner that a pointed end rests close to the center journal. In testing, use a thickness gage between the end of the indicator and the shaft, testing in all positions. If more than .002 in. misalinement is found, it will be necessary to straighten the shaft for best results. This is done on a straightening press, or, if nothing better is at hand, an automobile jack may be set on the center bearing, and a chain run around the end bearings and over the jack. While this method will take much time, it will give good results where the equipment is limited.

It is well, of course, to test the journals to see if they are round. If they are out more than .002 in., the shaft should be reground. Where minor scores show on the shaft, they may be dressed off with a fine cut file, after which the journal is polished with number 00 emery cloth.

With the shaft clean, straight, and polished, the scraping may proceed. First, take a light cut from each of the upper halves of the main bearings. Next, put a very small amount of bearing blue on each of the shaft journals, rubbing it with the finger until it is smooth and even. Then lay it in place and turn it several times to get an impression on the bearings. Use the bearing scraper to remove spots where the blue indicates that the shaft touches.

Proceed with the scraping and testing until a good bearing is shown on all the mains at once. At least a 75 per cent bearing should show before the upper halves may be considered finished.

Now fit the lower halves, having first scraped them to remove the scale. Test by bolting the cap to the case. Then loosen the cap to allow the shaft to turn freely.

Fit the front and rear bearings in the same manner. Provide just the amount of shims on each bearing so that when the bolts are locked tight, the same amount of drag is evident on each one.

In scraping bearings, a slightly greater amount of drag is permissible than is allowed when bearings are adjusted or merely taken up, because the new surface of the babbitt is softer and will seat more quickly than when the old surface is in contact.

The fitting of rod bearings by scraping is very similar to the process of scraping main bearings. It should be remembered, however, that the rod must be kept in line with the cylinder. Methods of alining rods will be treated next month.

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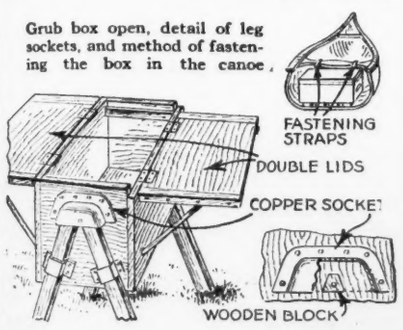
Canoeist's Grub Box Serves also as Dining-Table

By Leroy William Hutchins

DUFFLE bags and packs often are inconvenient for the camp food supply, so why use them when it is not necessary? The canoeist who does not have to portage can carry a grub box as easily and safely as the auto-camper.

While any box of suitable size will serve, added convenience may be had by using a box with a special table top and detachable legs. Such an arrangement is doubly handy by reason of having the food always "on the table"—the table is always set.

A grub box should not be any wider than the flat floor of the canoe at the place it is to rest. A good position, providing there is no live cargo, is just forward of the stern thwart. It should not be any higher than the depth of the canoe—preferably a little less. And it is good common sense to have thongs or straps



Grub box open, detail of leg sockets, and method of fastening the box in the canoe

attached for fastening the box to the canoe. This may be done by lashing it to a thwart or, particularly with the open-gunwale boat, to the gunwales. The danger of a box "slipping its moorings," possibly at a critical moment, is real and should be guarded against. It is, in fact, the one argument against the use of the grub box.

The box illustrated is 2 ft. long, 1 ft. wide and 1 ft. deep, made of ⅝-in. clear white pine. Simple butt joints, held together by screws, are used.

The cover is made double—two lids hinged to opposite sides of the box and one folding onto the other—to provide extra table space. This makes it necessary to have one side of the box the *thickness of the cover board* lower than the other; and the *under* lid must be the *thickness of one side board* less than the box width, and cut short enough to fit within the ends. To receive this lid when it is closed, small strips, ¼ in. thick, ¾ in. wide, and as long as the *inside width of the box*, are screwed inside the ends. The other lid folds down to form an over-all top to the box, and is fastened by a small hasp.

The lids, whether made of one piece each or two or more, should be reinforced by end battens about 1½ in. wide, screwed on, the screw heads being sunk in bit holes about ½ in. deep.

A simple brace for the lids is a small rod, either metal or wood, slipped into two holes bored at an angle of 45 degrees, one in the side of the box, the other in the under side of the leaf as it is opened into place.

(*Continued on page 104*)

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Canoeist's Grub Box

(Continued from page 103)

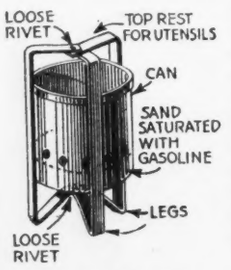
The legs are 1 by 1¼ in., 2 ft. long. The combination sockets and handles are bent to the shape shown by hammering sheet copper with a small ball-peen hammer into a form cut in a block of hard wood. When the socket is shaped, the copper is removed from the block, the outer edges are trimmed to the right size and shape, and holes are punched or drilled for screws.

A triangular piece of wood is fitted to separate the legs after the sockets have been fastened in place. The lower straps, through which the legs are slipped, are strips of metal 1½ in. wide and about 6 in. long. To make the loops the right size, the strips are bent around the legs to be used.

A good finish may be had by applying a coat of white shellac, followed by one or more coats of spar varnish.

Gasoline Camp Fire

IN MANY states open fires along the highways are not permitted and auto-campers are compelled to carry some sort of stove. Many types of safe and excellent gasoline stoves are available, but some campers, who ordinarily prefer an open wood fire, use an improvised gasoline stove made as shown, when an open fire cannot be laid. It consists of a large can, about 1 gal. in size, preferably without soldered seams.



The simplest type of gasoline stove

The can is perforated with a ring of ½- or 1-in. holes a little more than midway from the top, as indicated, to supply air and avoid excessive smoking; the correct number may be found by trial. A folding stand and dish-holder is made of sheet-iron strips. A layer of sand 1 or 2 in. thick is placed in the bottom.

In use, a pint or more of gasoline—the exact quantity for preparing a meal to be determined by trial—is poured into the sand and ignited.—G. A. L.

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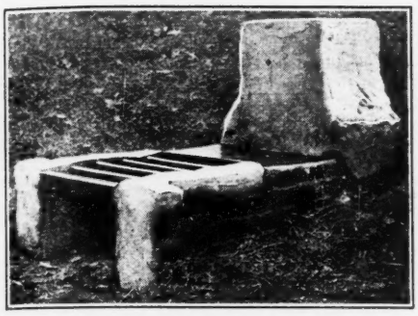
Building a Camper's Permanent Stove of Bricks

TO MAKE this camper's permanent stove, about 100 bricks, a sack of sand, and half a sack of cement are required. The inside width is about 3 ft. and the over-all length, 5 ft.

A double course of bricks is laid for the footing and the second course is laid



Ample space for boiling, broiling, and frying makes this an excellent camp stove

over the center of the first. The brickwork is five courses high.

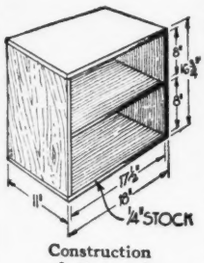
An iron plate is placed across the walls for the flue and the bricks are drawn 1 in. for each course to form the chimney. The stove is covered with a piece of sheet iron for boiling purposes, and several iron bars for broiling. An angle bar runs across the front end.

The exposed brick surface may be given a coat of cement and sand mortar all over, or merely where shown.—HERBERT C. CROCKER, Edwardsville, Ill.

Shoe Rack Saves Space in Crowded Clothes Closet

FLOOR space in a clothes closet always is at a premium. This may be saved by the use of a shoe rack placed across the base- or mop-board and backed up to the very end of the closet wall. By its use the floor is kept clear of shoes.

The rack can be made by knocking the bottom out of a box and inserting shelves. The box may be placed on a board set across the closet, if it is not wide enough itself. It is a simple matter, however, to build the rack especially to fit the closet. The wood should be shellacked or painted. — DONALD D. SIMONDS.



Construction of the rack

Cardboard Sanding Blocks

I FIND that heavy corrugated cardboard from shipping cartons makes excellent sanding blocks. The blocks may be made in any size or thickness desired by folding strips of cardboard. The edges may be given any curvature for sanding moldings and rounded surfaces, and no time need be lost in making shaped wooden rubbers.—R. E. DEERING, Clements, Kan.

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Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

THE etching of tools and other metallic objects is invariably accomplished by an acid. For the purpose of obtaining a design or a name on the metal, part of the surface must be protected from the acid bath. This protective covering is usually a mixture of wax and oil.

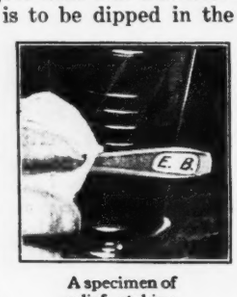
In intaglio work the design or name is sunk into the metal. In relief work, on the other hand, the design, when finished, is raised above the surrounding metal.

Intaglio work requires that the design or name be scratched with a needle or other sharp instrument in the wax coating on the metal. Relief work calls for the painting of the design on the metal with wax.

Name scratched in wax for etching (above) and application of acid (at right)

How the etched name appears after the wax protection has been removed (at left)

The covering agent, which protects the metal from being attacked by the acid, consists of a piece of paraffin the size of a walnut, a piece of beeswax half the size of a walnut, and about 10 or 12 drops of ozonized or Venice turpentine, all melted together over a small flame. Cover the entire metallic object with this wax mixture if the metal is to be dipped in the acid bath; otherwise make a tray of wax on the surface of the metal so that a small quantity of acid can be held in it. Then scratch the name or the design in the wax so that the acid will be able to attack the metal. This will result in a depressed design or intaglio. For relief work, paint the design with the wax and expose the rest of the metal, or as much of it as desired, to the acid.



A specimen of relief etching

(*Continued on page 107*)

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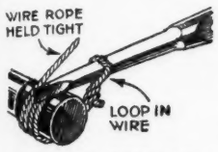
How to Unscrew a Pipe Cap without a Wrench

HAVING purchased a radiant gas heater, I found myself unable to connect it because I had no pipe wrench to remove the cap on the ¾-in. gaspipe. This cap was on tight and among all my tools there was nothing that would turn it. I took a piece of ordinary clothes-line wire about 1 ft. long, looped one end around a heavy screwdriver, put the screwdriver on the cap in the angle formed by the wire, wrapped the wire tightly around the cap about four times and raised up on the handle while holding the loose end of the wire in my left hand. The way that wire took the cap off was a real surprise. I don't believe that a pipe wrench could have taken a firmer grip.—R. C. WHITE, Dallas, Texas.



Using wire clothes line and heavy screwdriver

Rubber Buffer Will Protect Woodwork from Mallet

FOR driving parts of furniture together, I use as a buffer between the surface of the wood and my mallet or hammer a heavy piece of rubber. It is simply a rubber hockey puck with a hole bored in one side and a handle inserted.—S. B.

Home Workshop Chemistry

(*Continued from page 106*)

Iron and steel usually are etched with three parts of water to which one part of concentrated nitric acid has been added. A better formula is half a glassful of a concentrated solution of potassium bichromate in water to which a quarter of a glass of concentrated sulphuric acid is added. This solution also will etch copper and brass successfully.

Aluminum must be treated differently; it is etched with dilute hydrochloric (muriatic) acid.

When the place to be etched or engraved is very small, use a dropper to take up the etching fluid and place it on the name or design drawn through the wax. Renew the drops every five minutes or until the acid has penetrated deeply enough.

When the metal has been sufficiently etched, wash it in running water to remove all traces of acid and then take off the wax coating. This can be accomplished either by warming the metal and wiping off the wax, or by the use of a solvent such as acetone, benzene or turpentine.

It must not be forgotten that the metal has to be perfectly clean before the wax is applied, and after the wax is removed all traces of moisture must be taken off. When a tool has been etched, it is well to wash it with benzol containing a little wax to prevent rust.—ERNEST BADE, PH.D.

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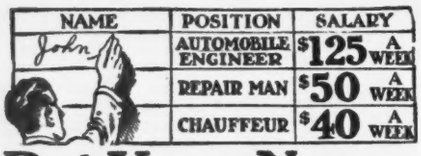

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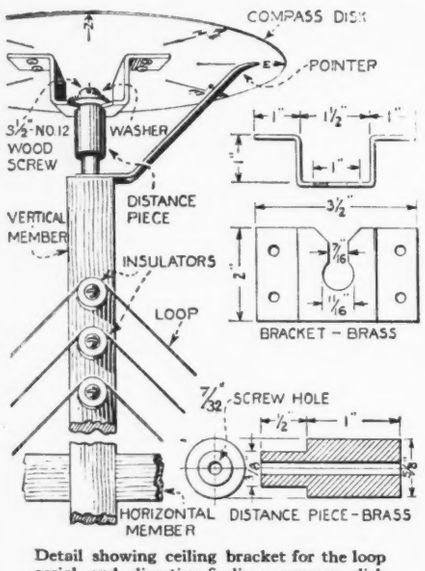
Space-Saving Loop Aerial Swings from Ceiling

By C. A. Oldroyd

SUSPENDING a loop aerial from the ceiling has several advantages over the usual custom of placing it on the radio cabinet or on a table. It can be swung around more conveniently and accurately and removed in a second without unscrewing any nuts. Furthermore, several loops of different sizes can be used at will in the same bracket support, if it is made as shown in the accompanying illustration.

To the vertical member of the loop is fastened a thin metal pointer, a spacer



Detail showing ceiling bracket for the loop aerial and direction-finding compass disk

or distance piece and a washer, as indicated, all being held by a single long wood screw. The supporting bracket is made as detailed and, together with a compass disk of any convenient size, is fastened to the ceiling.

In hanging the loop, the small end of the distance piece is slipped through the slot in the bracket and the whole frame is then dropped so that the large end fills the hole in the bracket. In this position the loop is held securely, yet it can be turned in any direction. The leads to the set should be flexible wire.

Fitting Unusual Joints

IN MAKING furniture with difficult joints, parts that have not been cut quite accurately often can be fitted by placing them as nearly as possible in their proper position, fastening them temporarily with clamps, or in some other way, and then running a fine saw through the joint to remove the projecting wood that caused the difficulty. If a panel or handsaw cannot be used, a short length of broken hacksaw or bandsaw will do as well. This plan also can be utilized in making picture frames.—G. E. BLACK.

Fine saw cut trues a joint accurately

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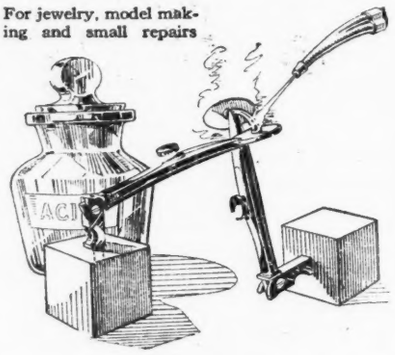
THE jewelry repairman and, in fact, any one who has had occasion to solder small articles, will welcome a method that does away with the usual bent pins and charcoal block. Having a great deal of repair work to do, I con-

For jewelry, model making and small repairs



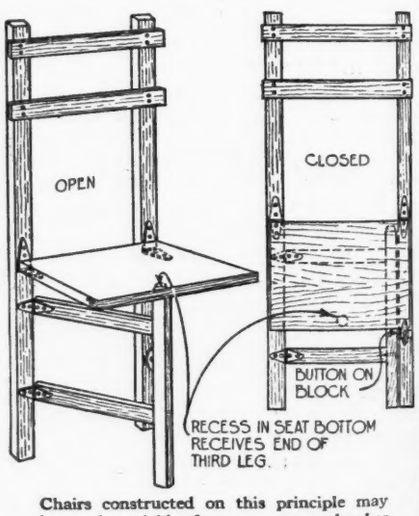
structed several of the clamps illustrated from old hinged ruling pens.

The base is a cube of nickel steel. A hole is drilled in the center of one of its faces to take the shank of the pen. The parts to be soldered are clamped between the points of the pens, which may be placed in various positions. Ruling pens of this old pattern usually may be purchased cheaply secondhand, if none can be found in the junk box or obtained from a drafting-room. — PHILIPPE A. JUDD, Portsmouth, Ohio.

Camper's Three-Legged Chair Will not Collapse Readily

EVERY camper has seen the ordinary types of folding chairs collapse at unexpected moments under the weight of their occupants. The chair shown in the accompanying illustration will neither close nor open unexpectedly, and it is of simple construction.

The uprights are 3 ft. 2 in. high and are placed 14 in. apart. The other dimen-



Chairs constructed on this principle may be made quickly from any scrap lumber

sions are in proportion. The principle of construction is not confined, however, to any one size, shape or grade of lumber. It will meet a host of varying tastes and conditions.—WILLIAM R. LEWIS, Eland, Wis.

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Be able to get the programs you like best any time and with that smoothness and clearness of tone that makes Radio most enjoyable. It's easy with

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LIBERTY TOP & TIRE CO., Dept. E-8 Cincinnati, Ohio

Constructing Airplane Kites

(*Continued from page 72*)

be covered on the under side. The cover may be a light-weight, tough wrapping paper. The edges should turn over the sticks and be glued down. Glue will require a little coaxing to keep it at work, so go over the work now and then while the glue is drying so as to press down places that have raised up.

After the cover is secure, lash the plane to the slanting sticks that are attached to the upright posts of the fuselage frame. See that the planes have equal amounts of overhang to right and left. It will be discovered that the lower plane frame extends through the frame of the fuselage, so covering is best done after it is anchored in place. The framework in place, including the rear plane, is shown in Fig. 4.

A brace is run from each side of the fuselage frame to the bottoms of the first pair of upright posts. Where the brace attaches to the upright post, drill a hole for about a 1/16-in. wire on which the wheels are placed (Fig. 4). Cover the fuselage from end to end before covering the under side of the lower foreplane.

THE rear or tail plane is shorter than the front ones, but is about the same width; it is 11½ in. by 36 in. The front end is lashed fast to the fuselage frame, but the rear end is left loose to be adjusted at the most advantageous angle. Its final anchorage can be made with wire or cord.

The rudder has a large reed, about No. 8, for the frame and is inserted in holes made for the purpose. Cover both sides of the keel. A movable rudder is not necessary, but might be useful if the keel veers too much to right or left.

Control is mostly through the kite line and adjustment of bridle. A two-line driving plan would be good, as a well balanced kite could be driven through a good many stunts.

A five-string bridle will serve for this kite—two strings from the front stick of the upper foreplane, two from the front stick of the lower plane and one from the rear of the fuselage.

When trying out this kite, it was found that the slant of the planes had to be reckoned with, so that the bridle, instead of standing at the usual ratio of 2 to 3, had to have almost the entire allowance given to the fifth string and only a small portion to the first four. In fact, the kite had to be drawn almost straight out, without any angling to the rear. This is an advantage, however, as it gives a more realistic appearance.

The propeller does not propel, but is for show. It can be whittled out of a soft piece of pine or redwood, about ¾ by 1 by 12 in., as shown at *I*, Fig. 2. A small hub should be glued to the front block, as shown at *H*, through which a hole is bored and on through the block to receive whatever bearing is used for the propeller. The propeller must be free enough to spin easily, but not so loose as to lop over on the frame of the airplane.

A UNIQUE method of making shades for electric lamps out of ordinary wooden chopping-bowls will be described next month by Gladstone Califf.

Mr. Bradford Is Right!

But the best advertisements of *this* tobacco are never written

From Indianapolis Mr. R. O. Bradford bursts into song:

The Pipe of Inspiration

I can see him now a-sitting at the desk he loved so well,
Late at night, and still hard at it, writing copy good to sell.
And he smoked his pipe in silence, while his thoughts to business ran,
Guess he's writing still, for father was an advertising man.

First he'd scatter all his papers, till his desk top was a sight;
Then he'd turn from his typewriter and gaze out into the night,
But when once his thoughts had started, and the work for sure began,
Dad would clean his pipe and fill it from the little old blue can.

Edgeworth! Bless your soul, you've guessed it! Dad was surely sold for fair,
On that ready-rubbed tobacco, and he never seemed to care
Just how long and hard his hours, or how high the work was piled,
All he wanted was the blue can, and he smoked his pipe—and smiled.

Pipe of inspiration. Righto. I'm an advertising man myself, and I've learned to realize and appreciate just how much Edgeworth means to me when there's a tough problem on deck, or when work piles up and requires long hours to clear it away.

Pass the good word along. It's Edgeworth that is responsible for lots of good advertising copy nowadays.

Ralph Otis Bradford

Mr. Bradford is quite right when he writes that "Edgeworth is responsible for lots of good advertising copy" for, as every writer knows, there *is* inspiration in a good smoke, but the words that fill this column do not sell Edgeworth. As a matter of fact, they *aren't* copy at all—they are just gossip about pipe smokers.

The advertising that creates Edgeworth smokers is broadcast from Jones to Smith to Robinson *by word of mouth*.

The best we can hope to do in this space is to get another Mr. Jones started.

Even if your name *isn't* Jones we'll be glad to send you free samples of Edgeworth if you'll send your name and address to Larus & Brother Company, 59 South 21st Street, Richmond, Va.

If you care to add the name and address of your regular tobacco dealer we will appreciate the courtesy.

To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Ready-Rubbed for the same price you would pay the jobber.

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for readers of "Popular Science"

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A convenient pocket manual for everyone in the building trades. Tells you everything you want to know about arithmetic, weights and measures, formulæ, mensuration, geometrical drawing, structural design, masonry, carpentry and joinery, roofing, plastering, plumbing, heating, ventilation, gas-fitting, estimating, elements of architectural design, etc. 372 pages. 189 illustrations. A wonderful bargain at $1.

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I. C. S. Business Man's Handbook
175,000 sold. A handy business book that no man should be without. Tells all about business forms, card systems, bookkeeping, correspondence, postal information, definition of financial terms, money and the money market, corporations, business law, contracts, partnerships, commercial paper, law of landlord and tenant, etc. 315 pages. 57 illustrations. Only $1.

I. C. S. Automobile Handbook
Tells all about gasoline engines, transmission and control systems, carburetors, self-starters, bearings, electric ignition, tires, automobile management and maintenance, horsepower calculations, how to make quick repairs, how to anticipate trouble, digest of automobile laws, and other useful information that will save you time and money. 301 pages. 156 illustrations. Only $1.

These five contain 1731 pages and 780 illustrations and represent the greatest book value ever offered at the price. Just fill in the coupon printed below—enclose $1 for each book you want, and mail. You run no risk. Your money will be returned promptly if you are not satisfied.

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Conns give you **FREE** most pleasure and quickest opportunity for profit because they are *easiest to play—beautiful in tone—perfect in scale*—handsome in design and finish.

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C. G. CONN, Ltd.
832 Conn Bldg.
Elkhart, Ind.

Rustic Bungalow Solves Housing Problem for One Family

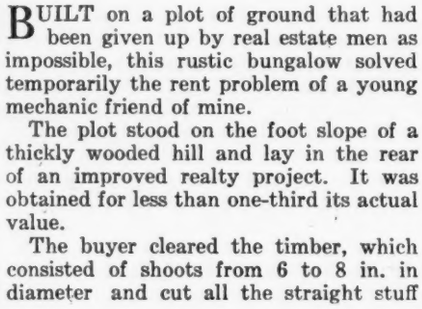
By Joe V. Romig

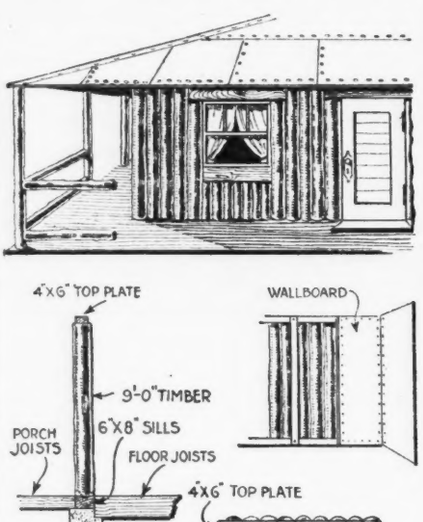
The inexpensive method of construction outlined in this article is especially suitable for a summer cabin in the woods.

BUILT on a plot of ground that had been given up by real estate men as impossible, this rustic bungalow solved temporarily the rent problem of a young mechanic friend of mine.

The plot stood on the foot slope of a thickly wooded hill and lay in the rear of an improved realty project. It was obtained for less than one-third its actual value.

The buyer cleared the timber, which consisted of shoots from 6 to 8 in. in diameter and cut all the straight stuff





Diagram, showing corner of log-cabin type of bungalow, and details of construction

up into 9-ft. lengths. He saved these pieces for the side walls of the bungalow.

A cheap cement foundation was first constructed and on this were laid the 6 by 8 in. sills. On these sills were set and spiked the rough 9-ft. logs. These were fitted closely together by trimming in places with an ax. By using the thickest pieces for the corners and door and window jambs, a strong and balanced locking design was obtained. On the top was spiked a 4 by 6 in. top plate, which carried the 2 by 6 in. ceiling rafters. These rafters extended over the porch.

The treatment of the interior was as simple as that of the outside. Strips 1½ by 3 in. were nailed on the logs at the proper intervals to catch the joints of wallboard sheets. The wallboard was nailed on with a gap between the pieces of about ½ in., which was later filled and smoothed over with plaster of Paris mixed with glue size and slaked lime to retard its setting.

This treatment of the wallboard joints gives a better job than when the pieces are butted closely against each other. The ceiling also was covered with wallboard and the job was completed with a covering of substantial wallpaper.

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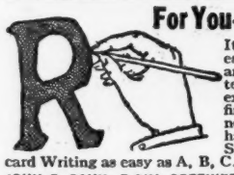

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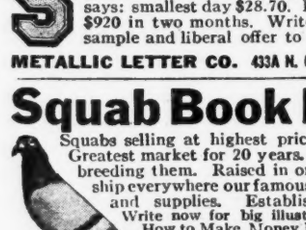
Drive This Beautiful Raceabout Instead of Your OLD FORD



Choice of Four Colors; Fiat or the Bullet Nose Radiator Shell. Send for 1924 Free Catalog of New Auto Acces', Bodies and Speed Equipment. Direct from Factory.
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Ready to hang.
Direct from the manufacturer.
Completely wired including glassware.
Send for Catalogue No. 26
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Special proposition to Dealers
ERIE FIXTURE SUPPLY CO.
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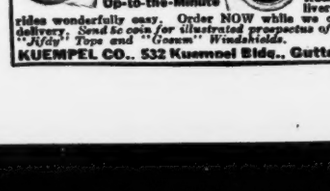
BUCHSTEIN'S FIBRE LIMB
soothing to your stump—strong, cool, neat, light. Easy payments.

Guaranteed 5 Years
Send for Catalog Today
Braces for all deformities,
P. BUCHSTEIN CO., 610-3rd Ave., So. Minneapolis, Minn.

Ford Runs 57 Miles on Gallon of Gasoline

A new automatic and self-regulating device has been invented by John A. Stransky, 2574 Fourth St., Pukwana, South Dakota, with which automobiles have made from 40 to 57 miles on a gallon of gasoline. It removes all carbon and prevents spark plug trouble and overheating. It can be installed by anyone in five minutes. Mr. Stransky wants agents and is willing to send a sample at his own risk. Write him today.—Adv.

MAKE YOUR FORD INTO THIS SPORT CAR ONLY $6.40
Other types down to $3.50. Famous sure fit, Ruxtell life-size patterns and picture instructions show how. You can easily convert your Ford into this fast, saucy Sport Car as hundreds have done with a few dollars worth of material from the hardware store. No need to lay up the car. The "PAL" with conical disc wheel pat. terns Pressed Metal Streamline floor only $6.40 delivered. Built low, rides wonderfully easy. Order NOW while we can make good delivery. *Send 6c coin for illustrated prospectus of Sport Bodies, "Kiddy" Tops and "Goozem" Windshields.*



Keen, Classy Up-to-the-Minute

KUEMPEL CO., 532 Kuempel Bldg., Guttenberg, Iowa

Wonder House of Science

(*Continued from page 23*)

that makes them visible. You are in effect looking into the realms of the invisible. You are seeing atoms, for you will undoubtedly recall that the little shooting stars called alpha rays, hurled off by radium at a speed of 20,000 miles a second, are picking up negative charges of electricity from the air and transforming themselves into atoms of helium.

Thus, in her new home, science shows us almost side by side two of her most amazing spectacles—one infinitely small, the other tremendously great—the movement of atoms and the activity of the sun.

Now, most of the things I have mentioned thus far belong to the realms of pure science—to the laboratory. Science, though, is intensely practical, and whenever possible speedily turns the discoveries of the laboratory to the service of mankind. And so in its new home Science lets us view a great many of the practical, useful things that have been given to us through scientific research.

There is, for example, an exhibit of valuable accomplishments of medical research. There are cultures of living disease germs; and there are microscopes in which you may place the germs and study them. Then, turning to graphic, understandable charts near by, you can see depicted the methods by which medical science combats these germs.

IN AN adjoining room are instruments by which the United States Weather Bureau makes its forecasts. Use them if you wish, and try to predict the morrow's weather from what you observe. It should be easy; the instruments are of the very latest types, and plain directions for their use are given. As a matter of fact, I predicted rain when I had read the instruments, and surely enough it did rain the next day.

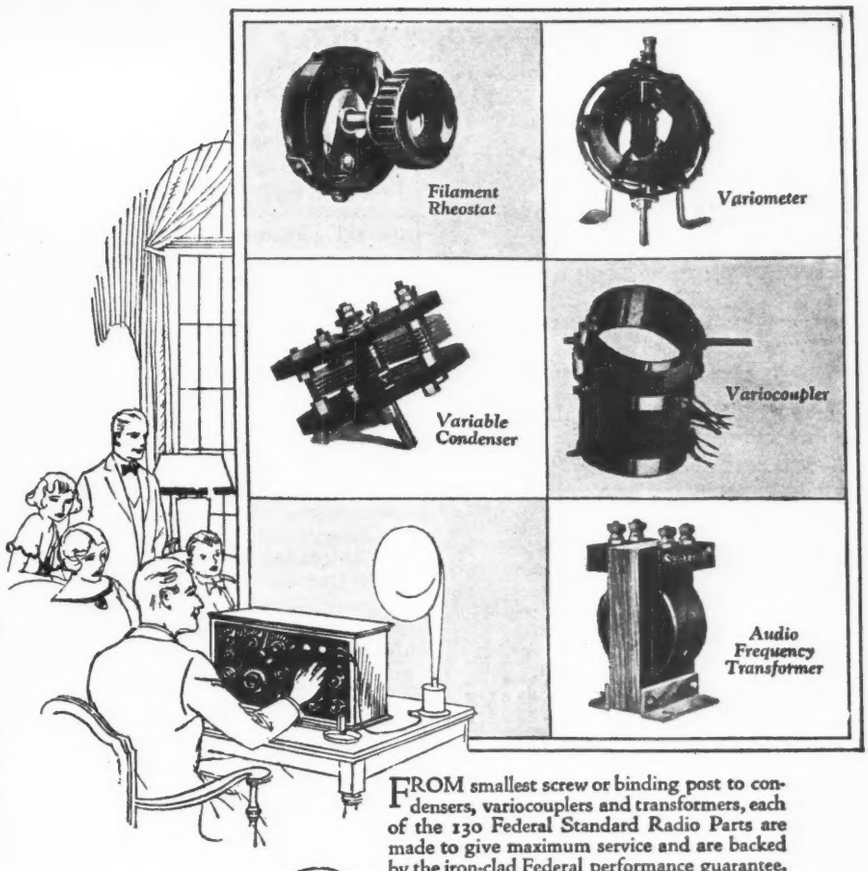
Alongside the Weather Bureau's exhibit is shown an actual example of what science has done to make man independent of the weather in the production of plants. Here are plants that have been grown by electric light. Beside them are other plants grown by sunlight. The difference between them is striking; the plants that have been absorbing artificial light throughout a 24-hour day are taller, more sturdy, more mature than those that have depended entirely on the natural duration of sunlight.

A few weeks ago it was announced that scientists of the General Electric Company had succeeded in developing a quantity production method for clear fused quartz, 65 per cent more translucent than glass, hence, an admirable substance for the manufacture of lenses, and offering medical science a way of utilizing the curative effects of light.

Samples of clear fused quartz are shown in the various stages of its manufacture, from rock crystals to a finished lens. This exhibit supplies an illustration of one of the underlying purposes of the new science building—to keep abreast of current scientific discoveries, and to present them to public view as soon as possible.

With this end in view, the exhibits, un-

(*Continued on page 112*)



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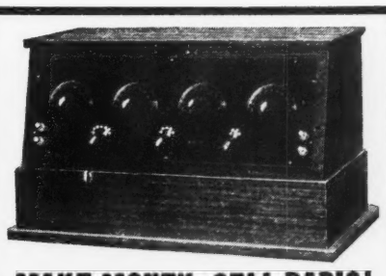

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Radio offers the biggest money-making opportunity on earth today. And the *Ozarka Plan* opens the door to this big opportunity. Look at the picture of this beautiful Radio Receiver. This picture was made from an actual photograph. By the Ozarka Plan that Radio Instrument can be the product of your own making—easily, simply and surely. It will be *yours to make, to sell* and *to reap* a rich reward in cash profits.

No experience necessary. You need not have much cash. All you need is spare time, determination and action. If you're that kind of a chap, the Ozarka Plan will start you on a straight line toward a real money-making business of your own. It can be as big and as profitable as you are ambitious to make it. We want good men in every county. Exclusive territory is going fast. Be sure and give us the name of your county. Write today for the Ozarka Plan. A wonderfully interesting book of facts, particulars and proofs. It is FREE. Act now.

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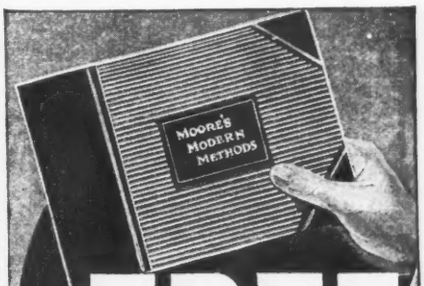

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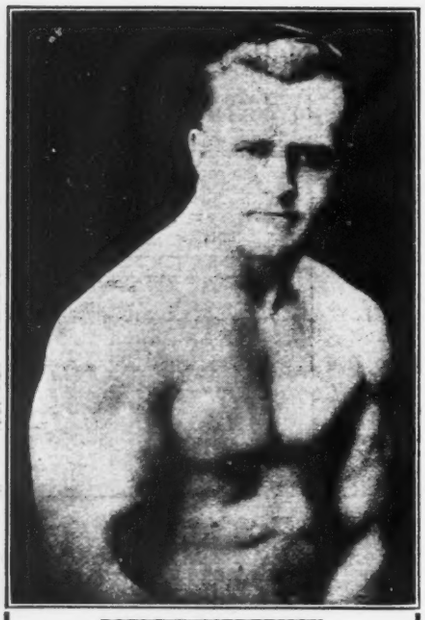
In Use In More Than 300,000 Offices



EARLE E. LIEDERMAN
The Muscle Builder

Rip Off Your Shirt

and get on the job. Work up a sweat and chase those disease bugs out of you. Gee, but they're happy with the chance you're giving them. Are you going to loaf around and let them eat up all your pep. Snap out of it, fellows. You're just digging your own grave when you refuse to exercise. Sitting back in a rocking chair and smoking your old Jimmy pipe may feel fine to a lazy man, but it sure raises havoc with your chances for a long life or a successful one.

WHO WILL HELP YOU?

I know you think you know all about it. Most everyone you meet tries to tell you how, but they can teach an oyster how to sing quicker than they can show you anything about muscle building. If you are in legal trouble, you seek a lawyer. If you are wise you get the best, for they are the cheapest in the long run. Now, how about that body of yours? Do you realize it is the choicest possession you have on earth? Don't be a plain dumb Dora! Use your head. This is vital with you. Muscle building is one of the trickiest studies on earth. I've worked at it ever since the day I left High School, so I ought to know. I've seen many a poor chap literally ruined by the wrong kind of guidance. On the other hand I've seen human wrecks transformed into human Hercules by being started in the right direction.

I'VE GOT THE WORKS

Come to me and I'll shoot you so full of strength and vitality you'll think it's your birthday. I'm the man that first guaranteed one full inch on your arm in 30 days. And I'm the man who does it. I'll fill out that chest so that it will take a man's size load of oxygen, shooting life into your blood and building up your whole body. I'll put a pair of arms and shoulders on you that will carry the kick of a mule. I'll shoot a quiver up your old spine and put a spring into your step so that you will feel like fighting a wildcat. This is no idle prattle, fellows. I don't promise these things—I guarantee them. You don't take any chances with me. I've got the works and I'm willing to prove it. Come on then—let's go.

Send for my new 64-page Book
"MUSCULAR DEVELOPMENT"
IT IS FREE

It contains forty-three full-page photographs of myself and some of the many prize-winning pupils I have trained. Some of these came to me as pitiful weaklings, imploring me to help them. Look them over now and you will marvel at their present physiques. This book will prove an impetus and a real inspiration to you. It will thrill you through and through. All I ask is 10 cents to cover the cost of wrapping and mailing and it is yours to keep. This will not obligate you at all, but for the sake of your future health and happiness, do not put it off. Send today—right now before you turn this page.

EARLE E. LIEDERMAN

Dept. 1308, 305 Broadway, New York City

EARLE E. LIEDERMAN
Dept. 1308, 305 Broadway, New York City

Dear Sir: I enclose herewith 10c for which you are to send me, without obligation on my part whatever, a copy of your latest book, "Muscular Development."

Name _____

Street _____

City _____ State _____
(Please write or print plainly)

Wonder House of Science

(Continued from page 111)

like those of the ordinary museum, are mobile. They will be changed about, removed, or replaced with every new step in scientific progress. The seismograph, the Foucault pendulum, and a few similar instruments that demonstrate fundamental phenomena of nature, are the only ones regarded as permanent.

Beside the clear fused quartz is a photo-electric cell, the contrivance used in talking movies, in control of torpedoes and boats by searchlights and similar extraordinary inventions.

There is an X-ray machine with which photographs can be made of your internal organs. This is one of the few pieces of apparatus in the building with which you are not invited to experiment, for it requires a trained operator.

You will find, too, an exhibit prepared by the Smithsonian Institution—fossils, meteorites, and similar discoveries that have enabled science to peer into the dim caverns of the past and unfold to man the history of the earth, and to explore the wonders of the heavens.

WHAT I have given here is merely an impression of a few of the furnishings of this new home of science. There are many others, all of engrossing interest to the most casual visitor.

The building itself is a palace. Art and science have joined to make it a conspicuous addition to the many beautiful buildings of Washington. Its construction marks the realization of a dream of Dr. George Ellery Hale, director of the Mount Wilson Observatory, who several years ago conceived the possibility of a national home for science. The gift of $5,000,000 by the Carnegie Corporation to the National Academy of Sciences and the National Research Council made the erection of the building possible. It cost $1,450,000, the remainder of the gift being reserved for maintenance.

"Our aim is to assure the future of science," Doctor Hale told me, "by supplying here a meeting place for pure science and its applications. We wish to give visitors a chance to peer beneath the surface of the examples of applied science they encounter in their every-day life and to see and appreciate the work in pure science that has made them possible. Thus we hope to interest many people in the fundamentals of science. Who can say that we may not awaken an interest in some—the young especially—that will cause them to embrace careers in science?"

This new building in Washington furnishes a reminder to all of us of what we owe to science, a thought beautifully expressed in the dedicatory inscription that encircles the base of the handsome dome:

"To Science, Pilot of Industry, Conqueror of Disease, Multiplier of the Harvest, Explorer of the Universe, Revealer of Nature's Laws, Eternal Guide to Truth."

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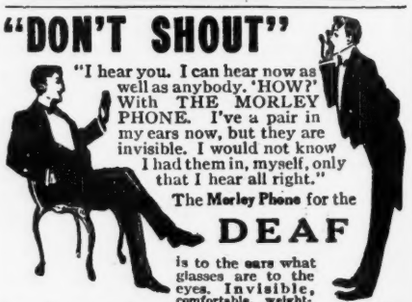

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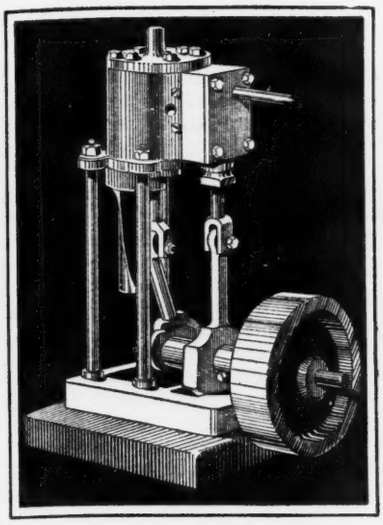

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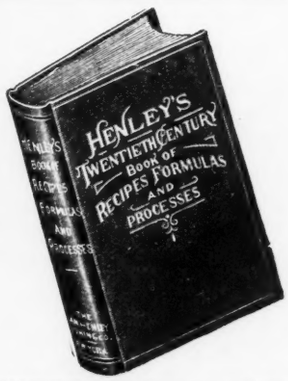

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How to Build a Small Home for Less Money

(*Continued from page 63*)

be added later when you can afford it, and its omission should save from $550 to $750 in the initial cost. If you decide you need a basement, there is a chance to save from $75 to $125 by omitting partitions for laundry, heater room, etc. These can be added at any time.

In the kitchen a very large item of expense lies in built-in fixtures, which cost anywhere from $125 to $350. Good ready-made kitchen cabinets usually are cheaper and will give very satisfactory service. A stock refrigerator, instead of a built-in refrigerator with waste and platform, will save you from $20 to $40. Omission of a clothes chute will save possibly $25 more.

In selecting plumbing fixtures for the kitchen, you will find that durable enameled iron is less expensive than chinaware. A wooden drainboard for the sink will cost less than an enameled iron drainboard. Separate faucets will be several dollars cheaper than combination hot and cold water faucets.

In the bathroom, too, considerable saving can be made by using enameled iron instead of porcelain for bathtub and lavatory. For the lavatory the saving may be at least $30. A simple bathtub with legs usually is about $40 cheaper than a recess tub. While tile flooring for the bathroom is desirable, you can get along very well without it, thus saving an expense of at least $30 or $40.

Of course, every one wants a cheerful fireplace in the living-room; but do you need it? Here is a chance to save probably $350 in labor and material.

I have mentioned here just a few of the outstanding points that present opportunities to cut costs. There are dozens of other items, such as built-in china closets, bookcases, wardrobes and closets, that may be eliminated without sacrificing comfort and happiness. Then, too, there is a great chance to cut expenses in selecting materials for the interior construction.

Stock doors, moldings and sash, for example, will cost less than those of special sizes and special design. Again, the use of a medium grade of oak flooring instead of first grade wood is likely to represent a saving of $100 on your home. For the wood trim, too, soft wood is less expensive than hard wood. Fir or pine, if painted, will be attractive and will give excellent service, while saving you anywhere from $125 to $175. Then in your selection of plain electric fixtures and hardware, which are in the best of taste, you should be able to save at least $200.

And so you can go through your building specifications, studying every item of material, equipment and labor for a chance of reducing its cost without impairing its usefulness. In almost every clause you will find some element, small or large, that represents an unnecessary financial burden. Cut it out. In the end you will be surprised at the total amount you can save in building your home.

Another useful and informative article on home-building will appear in the September POPULAR SCIENCE MONTHLY.

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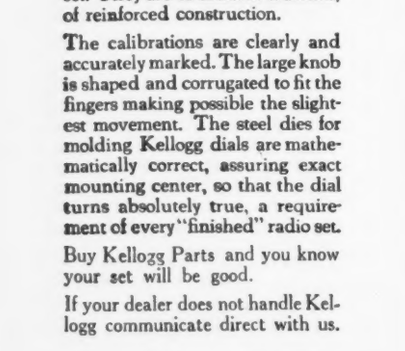

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P.S. ---

Telepathy Put to the Test

(Continued from page 32)

room knew what commands I would give.

In a very short time after the start he arrived at the desk, picked up a number of objects repeatedly and threw them down again nervously. For instance, he picked up a letter three times, struck or tapped the desk with it, and swung it up and down each time he took it up, as you or I might do absent-mindedly. Then he passed on with an air of aimlessness to the next object.

At last he reached the box of matches. First he picked up the entire box and threw it down again; he took out a single match and tossed it back; another he took up and tapped the desk with it; a third, after being tossed in the air a moment, was used to poke the others in the box. Then he took up a match with an air of decision; whereupon I "thought" the next command which was, as I said above, to carry it to the little table on which were the water pitcher and the inverted tumblers.

After a great many more apparently "try, try again" movements, he put the match into a tumbler, shook it about, took it out as if he believed he had done the right thing, and set about obeying my next and last command, which was to go across the room to the telephone stand and to place the match upon the stand beneath the instrument. Here were more "try, try again" movements, and at last a decisive act that successfully completed the experiment.

CERTAIN features of behavior of those who obey "mental commands" and who "find things," suggest the hypothesis that the experimenter himself, wholly without intention and quite unconsciously, makes signs that are observed and interpreted by the "telepathist"; signs that guide him in the way he should go and that tell him when he has finished.

For example, in the experiment I have described, I may have caught my breath involuntarily when my subject was dabbling at the match box and at the inverted tumbler. When he was approaching the box, I may have inclined my body forward ever so slightly or drawn back, according as I wished him to succeed or to fail, precisely as my neighbor on the bleachers at a football game unconsciously pushes toward me or away from me according as he *wishes* or expects the team to drive this way or that.

Now the hypothesis is that the "telepathist" in the case I have cited caught just such movements, or analogous movements, on my part—my facial expression, the sounds of catching my breath, and other involuntary signs from which he drew the inference that he was on the right or the wrong track. His frequent repetition of a movement, such as picking up and throwing down a letter, may be interpreted as ways of "fishing" for a repetition of my signs of approval or disapproval.

Of course, my subject's eyes were not directed toward me, but I was always in position, a little behind him and toward his right, so that he could see me out of the tail of his eye. Such a condition affords, as every student of vision knows, an excellent opportunity for detecting small movements. The reader can easily satisfy himself upon this point if he will hold his index finger steadily at the side of one eye and so far back toward the tip of the ear that it is just invisible. Now let him wag his finger and immediately it becomes visible only to be "out of sight" again once he holds it quite still.

The fact is that probably all of us have far too mean a conception of the capacities of human nature for detecting slight sensory impressions and small differences among gross impressions. Consider the ability of the blind to make their way from place to place among obstacles, guided by slight differences of air movement against their cheeks, by the feel of the ground beneath their feet, and possibly by the faintest auditory cues. And let us not forget too, the totally deaf person who understands what you are saying so long as he can hold his hand upon your head or shoulder or upon the back of your neck.

Such considerations as these led me to make another test of the remarkable abilities of the so-called telepathist. This time a five-cent piece had been hidden in an overshoe worn by one of the observers. If the subject should find the coin, he was to about-face and throw it against the door at the opposite side of the room. For my part, I was determined to check my involuntary movements while attention was riveted sharply on the things the subject should do. The result was that it took the subject three-quarters of an hour to find the coin. And he never succeeded in throwing it against the door.

THIS, of course, is not absolute proof of the efficacy of my own involuntary movements as signs to the subject, but it does certainly strengthen the hypothesis I have advanced.

Once more, it is not impossible that hearing may play a part in some instances that pass for telepathic communications. Many a person will discover that when he is thinking his vocal apparatus is at work. He is *incipiently speaking*. This is especially true when he is closely attentive to what he is thinking. Some people have reported that their throats are tired after having listened for an hour to a lecture or to a concert. They have been incipiently saying the words of the speaker after him or singing after the vocalist.

Inevitably such action of one's vocal organs will set in motion a column of air in the mouth and nasal cavities. These vibrations will be communicated to the air exactly as in normal speech, and a sufficiently sensitive ear could catch them.

In the foregoing examples we have considered only alleged telepathic communication or transfer of thought between persons physically close to each other. What is to be said of communications of the sort where great distances are involved?

Recently Dr. Gardner Murphy of Columbia University, Dr. H. B. English

(Continued on page 115)

Telepathy Put to the Test

(*Continued from page 114*)

of Antioch College, and the writer undertook a test of the reality of telepathic communication at a distance. We operated from the Zenith Radio Station in Chicago. We went at it frankly as experimentalists and with no predetermination that we should find any given sort of evidence either for or against.

The radio was used in this instance merely to make our announcements to the public at large. A week before the test it had been made known from the radio station that such an experiment would be attempted. So on the evening of the test it was announced that those around the transmitter in Chicago would be thinking of:

1. A number between one and one thousand. Listeners were asked to report by telegraph or mail what impressions they received, if any. The number was 664. Of 2010 replies none was correct.

2. An animal illustrated on a chart before us. Above it on the chart was a capital letter. What animal and what letter? Two persons correctly reported a walrus and nineteen were correct in reporting "S." Each of these is below the theoretically chance figure.

3. Two intersecting lines, one of them colored. What was the color and what the angle of intersection? Two hundred and fifty correctly reported yellow, which is somewhat below a chance result, assuming that the colors of the rainbow include all possible choices. The angle formed by the crossing lines was about 73°. Apparently no one reported this rightly.

4. The senders were eating a certain food. What was it? No one answered "beets."

5. Each sender was suffering pain. Where was it located? Only three correctly reported the palm of the left hand just below the little finger. Two were nearly right. Taking 76 arbitrarily chosen areas on hands and arms as affording material for choice, we again were dealing with purely chance results.

6 and 7. Here the attempt was to transmit the impression of an emotional scene. We were looking upon the picture of a drowning man and upon that of a fireman rescuing a child, respectively. Again there was nothing in the return to attract attention.

So far nothing but negative results have come from the experiment, and it remains to be seen whether any of the listeners who replied correctly will yield anything of interest under further experimentation.

In fact, the systematic and extensive experimental work that has been done in this connection by Doctor Coover of Stanford University and others has yielded such overwhelmingly negative results that the field offers little encouragement to stimulate more than a very few research students. This observation applies particularly to those situations in which distance is a factor.

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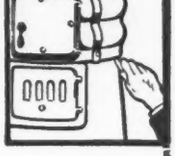

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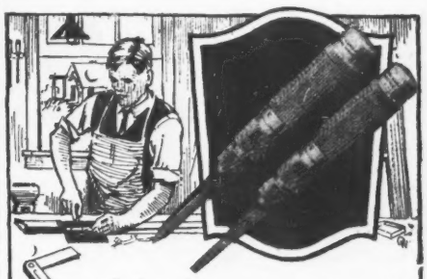

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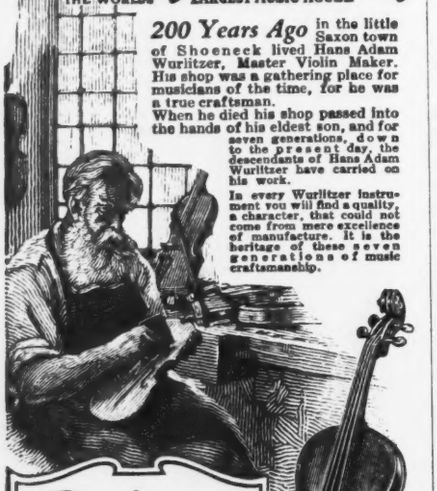

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Building a Five-Tube Loop Set

(*Continued from page 66*)

winding are connected with their corresponding switch points in order.

The top end of the winding also is connected with terminal *B* of jack 4. Terminal *C* of jack 4 is connected with the ground post 2. Next, run a wire from terminal *D* of jack 4 to the *B* (rotary plates) terminal of condenser 8, and another wire from the switch arm of switch 6 to the slider terminal *B* of potentiometer 7. Connect these two wires by a short length of wire. Another wire then can be used to connect terminal *A* of jack 4 with the *A* (stationary plates) terminal of condenser 8. This wire is connected with the *G* terminal of socket 10. The wiring of the tuning unit is completed by connecting the switch arm of switch 5 with the aerial post 1.

Next, begin the filament wiring by connecting binding post 30 with *A* terminal of switch 25. Then connect, in the order named, *B* terminal of switch 25, *B* terminals of rheostats 24, 19, and 15, and *C* terminal of potentiometer 7. Run a wire from binding post 31, along the baseboard just in front of the *F* terminals of the sockets, to terminal 11. This wire will extend practically the length of the baseboard.

Short lengths of wire are used to connect this wire with the following terminals: The F_1 terminals of sockets 10, 14, 18, 23, and 28; *A* terminal of potentiometer 7; one terminal of fixed condenser 9; *F* terminals of variotransformers 13 and 16. If dry-cell tubes are used, *F* terminal of transformer 13 should be connected with negative A-battery lead.

The *A* terminal of rheostat 15 is connected with F_2 terminals of sockets 10 and 14; *A* terminal of rheostat 19 with the F_2 terminal of socket 18; *A* terminal of rheostat 24 with the F_2 terminals of sockets 23 and 28.

CONNECT *P* terminal of socket 10 with *P* terminal of transformer 13. The *B* terminals of transformers 13 and 16 and the remaining terminal of condenser 9 all are connected with terminal 12.

The *G* terminal of transformer 13 then is connected with *G* terminal of socket 14; *P* terminal of socket 14 with *P* terminal of transformer 16; *G* terminal of transformer 16 with *A* terminal of grid condenser and leak 17; *B* terminal of grid condenser and leak 17 with *G* terminal of socket 18; *P* terminal of socket 18 with *A* terminal of jack 22; *P* terminal of transformer 21 with *B* terminal of the jack; *B* terminal of transformer 21 with *C* terminal of the jack; *D* terminal of the jack with terminal 20.

Next, connect *A* terminal of jack 27 with *P* terminal of socket 23; *B* terminal of jack 27 with the *P* terminal of transformer 26; *C* terminal of jack 27 with *B* terminal of transformer 26; *D* terminal of jack 27 with *B* terminal of jack 29 and with terminal 32.

Connect *P* terminal of socket 28 with *A* terminal of jack 29; *G* terminal of transformer 21 with *G* terminal of socket 23; *G* terminal of transformer 26 with the *G* terminal of socket 28.

A standard 4½-volt C battery can be placed between sockets 23 and 28 and the back edge of the baseboard. The positive terminal of the battery should be connected with the *B* terminal of rheostat 24. Connect *A* terminals of transformers 21 and 26 and connect them with the negative 4½-volt terminal of the C battery.

Insulated wires to serve as battery leads then are soldered to terminals 11, 12, 20, and 32 to connect the terminals with the B battery. If a soft detector tube is used, the lead from terminal 20 should be connected with a B-battery voltage of 22½ volts or less. If hard tubes of the UV-199 or UV-201 *A* type are used throughout, the No. 20 terminal should be connected with a B-battery voltage of from 45 to 67½ volts. Terminal 11 should be connected with the negative terminal of the B battery. Terminals 12 and 32 should be tried on various voltages from 45 to 90 volts until best results are obtained.

The positive A-battery lead should be connected with binding post 31, while the negative A-battery lead should be connected with binding post 30.

The novel arrangement of aerial and ground posts and tuning unit in connection with jack 4 makes it possible to use outdoor, indoor, and loop aerials with the set in various ways.

Usually if an outside or indoor aerial of the ordinary single- or double-wire type is used, the aerial is connected with the aerial post 1 and the ground wire with ground post 2.

WHEN a loop aerial is used, one terminal of the loop may be connected with aerial post 1 and the other terminal with post 2. The switch arm of switch 6 may be set on the "blind" contact *X* of switch 6 to disconnect it from the coil. A number of turns of coil 3 can be connected in series with the loop to aid in tuning by setting the switch arm of switch 5 on the various switch points.

The loop may be used without any portion of the coil by connecting the two ends of the loop with the terminals of an ordinary phone plug, inserting the plug into jack 4, and setting the switch arm of switch 6 in the "blind" contact *X* of switch 6.

In tuning the set, the rough adjustment for wave length is obtained by setting the switches when an outdoor or indoor aerial is used and by adjusting the variable condenser. The finer adjustments for wave length are obtained with the variotransformer dials and the Vernier plate of the variable condenser. Control of destructive regenerative effects is obtained by adjustment of the variotransformer dials, rheostats, and potentiometer.

If properly constructed, a receiver of this type should give more efficient operation with greater freedom from static and interference when used with a loop or short indoor aerial, than a highly efficient three-tube set will give when used with a very good outdoor aerial system.

IN RESPONSE to many requests from our readers, Mr. Calcaterra's article in next month's issue will describe how to build a remarkably sensitive superheterodyne receiving set.

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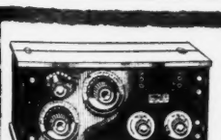

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"Most Terrible Invention"

(*Continued from page 34*)

electrical conductivity increased by as much as several million times.

And so a beam of ultra-violet light sufficiently powerful would have just the effect that is claimed for the carrier beam. It would form a conducting path for the transmission of powerful electric currents through the air. Perhaps this is not exactly what the carrier beam *is;* but it is what the carrier beam might be. Many experts who have studied the Grindell-Matthews' experiments and those of other inventors are of the opinion the secret lies in some application or modification of this ionizing power of the ultra-violet rays.

AT PRESENT the claims of the several inventors have attracted public interest largely from the standpoint of the possibility of their use in warfare. A beam directed against an unprotected war-ship might succeed in exploding its ammunition or damaging its operating mechanism. Similarly, conceivably, such an invention might be effective against aircraft, although two carrier beams would be necessary, one to carry the outgoing current, the other to serve as a return path to the ground.

However powerful such beams may be, it is also possible, as the British Air Ministry pointed out in pronouncing the Grindell-Matthews ray harmless, to protect war craft more or less perfectly against such a ray. All that is necessary, Mr. Grindell-Matthews himself admits, is to shield the magneto and engine with a metal cover. To protect an armored automobile the car could be surrounded with a metal shield and a metal chain or flexible cable dragged along the ground to connect the shielding metal with the ground.

It has been demonstrated that unquestionably a ray can be developed and shot out for short distances with unknown possibilities of destructiveness. But whether such a ray can be put to use as to be an effective and deadly agency in warfare has not yet been proved. And even should such a beam, when fully developed, have the grim potentialities inventors claim for its use, the result undoubtedly would be an inventive struggle between offensive use of the ray and defensive protection appliances.

OTHER possibilities of such a device, however, involve real creative work for mankind. For example, the old dream of wireless power transmission, suggested so often by Nikola Tesla, a man to whom Mr. Grindell-Matthews gives credit for having been the inspiration of his investigations. If such beams can be used to explode powder or deal electric death, they can be used also to carry power from one point to another without wires.

Also they can be used in burglar alarms and similar devices for protecting property. Imagine, for example, the necessity of protecting a government warehouse against unwarranted entry. Four ultra-violet rays, each charged with high-voltage current might be arranged to

(*Continued on page 118*)

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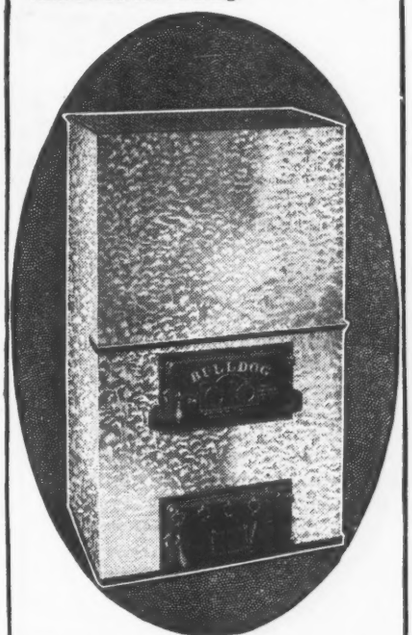

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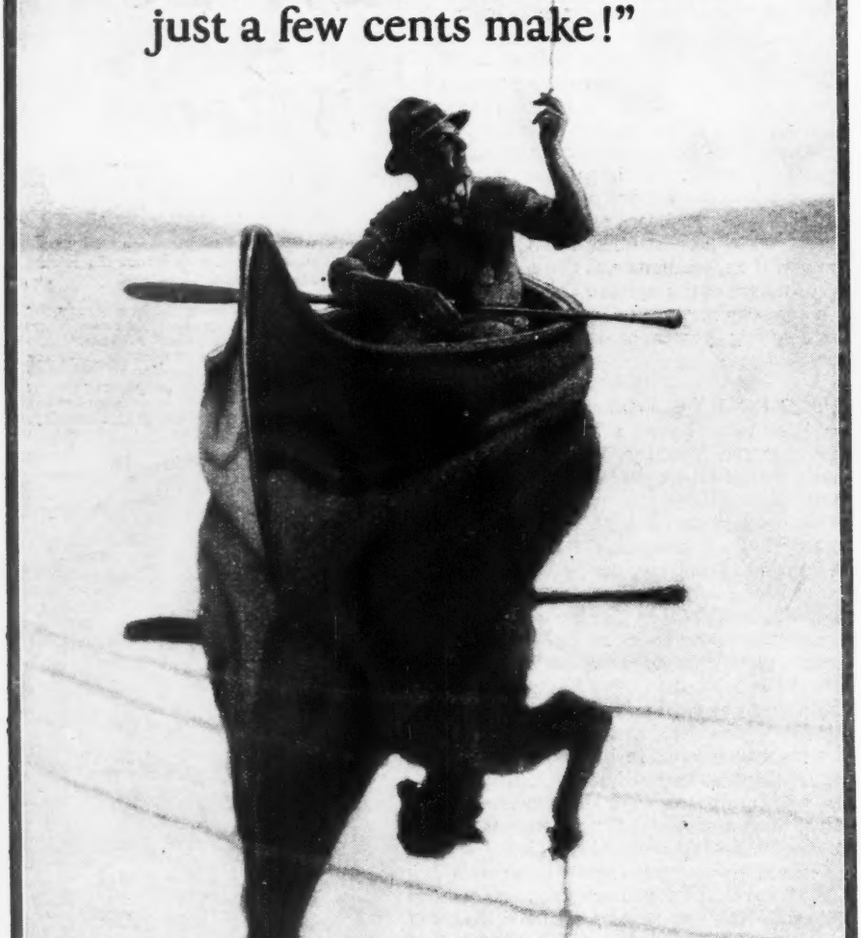

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"Most Terrible Invention"

(*Continued from page 117*)

make a fence around the four sides of the plant at about the height of a crouching man. No man would find it healthy to attempt the passing of such an invisible barrage.

It is far from certain, of course, that Mr. Grindell-Matthews or any other inventor actually has solved the problem of sending such power rays over considerable distances. The experiments reported so far have involved distances of only a few feet.

If some variant of ultra-violet light is really the secret of the carrier beam, one of the main difficulties to be expected in using it is the absorption of the rays by the air. This means that the beam will become rapidly weaker, and experiments that are successful enough over short distances may not be so striking when the distance is increased to many yards or to a few miles.

THESE questions can be answered, of course, only by further experiments. Such experiments are reported to be in progress. But with the many peacetime uses of such rays, including, for example, the recent experiments in Paris on the use of ultra-violet light as a cure for cancer and the possibility already suggested that the charged ray of Mr. Grindell-Matthews may prove still more beneficial in this disease, it is probable that power-charged rays of some kind will play an important rôle in the science of the next 10 years, even if their use in distant warfare proves to be impracticable.

Recent Publications

A résumé of new books on science and invention

The Depths of the Universe, by Dr. George Ellery Hale, honorary director of the Mt. Wilson Observatory. Three absorbing popular essays on the wonders of the heavens. Illustrated. Charles Scribner's Sons.

The Romance of a Living Temple, by Frederick M. Rossiter, B.S., M.D. An interesting popular study of the human body. George Sully & Co.

Super-Power as an Aid to Progress, by Guy E. Tripp, chairman, board of directors, Westinghouse Electric and Manufacturing Company. A collection of articles and public addresses. Illustrated. G. P. Putnam's Sons.

Popular Research Narratives, edited by Edwin E. Slosson. Fifty stories of discovery, invention, and research collected by the Engineering Foundation. Williams & Wilkins Co.

The Einstein Theory of Relativity, by Garrett P. Serviss. Many phases of this little understood subject made plain by graphic comparison. Illustrated. Edwin Miles Fadman, Inc.

Science, Old and New, by J. Arthur Thomson, M.A., LL.D., professor of natural history, University of Aberdeen. A collection of essays on biological subjects by the editor of "The Outline of Science." G. P. Putnam's Sons.

Eyeless Sight, by Jules Romains. Can we learn to see with our skin? G. P. Putnam's Sons.

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Here Are Correct Answers to Questions on Page 57

1. It is the weight of a body compared with the same weight of water. Thus the average specific gravity of rock is 2.77, which means that a cubic foot of average rock weighs just 2.77 as much as a cubic foot of water.

2. The force that starts the shot forward, that is, the force of the explosion, exerts an equal force backward. This is one of the famous laws of motion discovered by Sir Isaac Newton; the law that for every action there is an equal and opposite reaction.

3. Possibly, but it has never been done. There are always a few detached molecules drifting around in it as gas molecules. The most perfect vacuum ever made still contains about eight billion molecules to the cubic inch.

4. Mainly because some are hotter than others. The hottest ones contain certain gaseous chemical elements that shine with an intense white light. The stars that are a little less hot shine with a yellowish light and the coolest stars of all shine with a reddish light.

5. Oxygen, the same gas that is in the air. Oxygen makes up nearly 50 per cent of the known rocks of the earth. This is not believed to be true of the earth all the way through. If you take the earth as a whole, the commonest element is probably iron, though there is no way of proving this.

6. All of the fluids in the body and all of its secretions are more or less salty. Living matter is accustomed to salty solutions. If the tears were not salt, they would hurt the delicate membranes of the eye.

7. When a great many electrons pile up in one place, they are likely to jump suddenly to some other thing that is close. This makes an electric spark. It is billions of electrons jumping from one place to another.

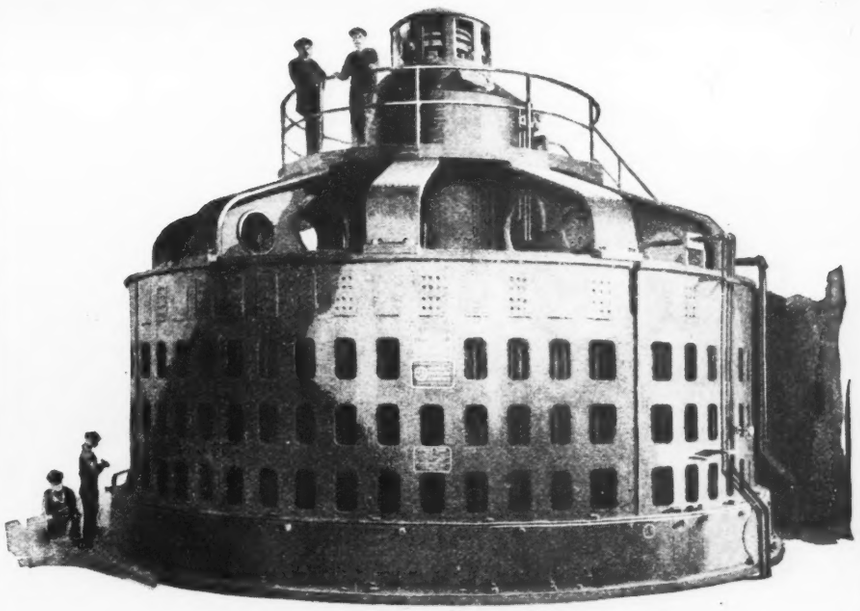
8. Heat is due to the very rapid vibration of the atoms of matter. For instance, a piece of iron is hot when the billions of tiny iron atoms in it are vibrating very rapidly back and forth. It is cold when they are not vibrating so rapidly.

9. They breathe the water. When we breathe we get oxygen out of the air. There is also oxygen dissolved in water and the gills of the fish take up this oxygen, just as our lungs take up the oxygen of the air.

10. Fog is simply cloud close to the earth. It is formed whenever moist air gets cool enough to condense its water molecules into small drops.

11. The gray matter, or what scientists call the "cortex." This is a thin layer, from one-tenth to one-quarter of an inch thick, spread over the surface of the upper part of the brain. The thing that distinguishes man and the higher animals from the more lowly ones is that the gray matter is on the outside of the brain, where it has room to grow. In the brains of snakes, frogs and other lower animals the thinking part of the brain is on the inside, where any great growth is impossible.

12. So that he will be seen less easily when he hides in thickets of tall grass. The stripes look so much like the lights and shadows on the blades of grass that the tiger is very well concealed.



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Nature's Super-Power Plant

(*Continued from page 25*)

For example, not long ago lightning traveled down the elevator cable of a mine 2000 feet deep. Two miners who were preparing a blast were injured severely when a charge of dynamite was exploded by the flash, and 25 others at the other end of the tunnel were shocked.

About a year ago a man in one of the New England states, running for shelter from a sudden storm, saw a sudden blinding flash followed immediately by a terrific crash of thunder. Then he was conscious of a peculiar numbness in his body. That he had been struck by lightning, though, did not occur to him until he noticed that his shoes had been torn from his feet.

A somewhat similar case is that of a man who was struck while standing under a tree on a farm in New York several years ago. He was knocked unconscious, one arm was broken and he was badly burned. Strange to say, he was absolutely naked when he was found and the field about him was strewn with bits of his clothing.

SCIENCE recognizes several kinds of lightning, although authorities differ as to whether some types are not identical and merely appear different because of the peculiarities of human vision. Zigzag or forked lightning is the most common type. The irregular path of the discharge is believed to be due to the presence of solid particles and electrical charges that make a jagged course along the path of least resistance.

Sheet lightning, which illuminates large areas of the sky without storm, is generally believed to be merely the reflection of forked lightning from a distance. Band lightning, a broad ribbon-like stroke, is caused by a rapid succession of discharges along a path that has been slightly displaced by the wind. Ball or globular lightning is very rare, if it occurs at all.

Bead lightning, which is described as a chain of luminous balls, is another type of lightning regarding the existence of which authorities are not agreed. There is also St. Elmo's fire, a globular light observed infrequently on masts of ships.

In addition to all these there are induced charges—local electrical disturbances between metallic bodies, accompanying the discharge of lightning near by. These frequently cause fires if inflammable material is near, but are not generally dangerous so far as human beings or animals are concerned.

The vast majority of victims of lightning are not killed instantly. They are merely stunned and can be revived by the application of artificial respiration and the other first-aid measures commonly employed in cases of drowning or asphyxiation.

Like many other manifestations of the mighty power of Nature, lightning is coming gradually under the control of science and when the public generally understands the nature of lightning and the means of avoiding its dangers, its hazard to human life and property will become virtually extinct.

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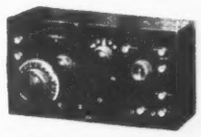

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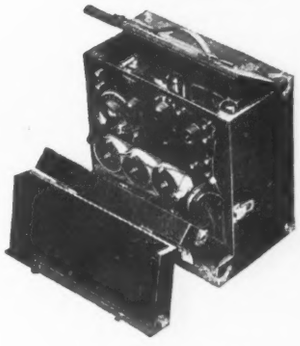

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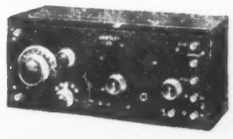

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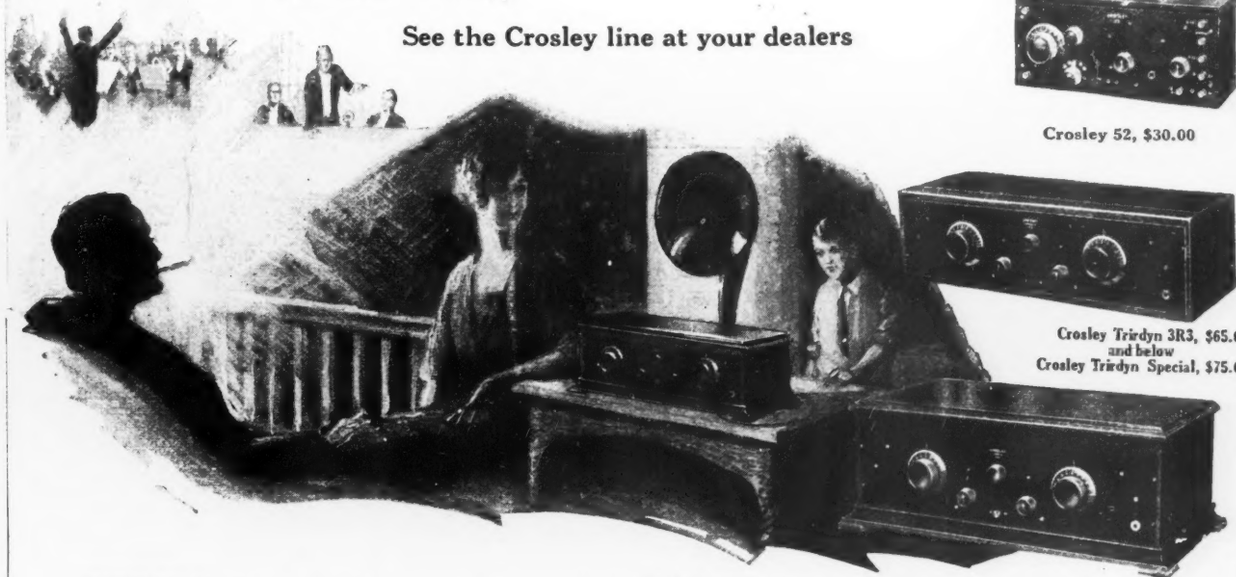

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